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# PROCEEDINGS OF PUBLIC MEETING ON WATER QUALITY MANAGEMENT FOR ESTUARIES, HELD IN SAN FRANCISCO, CALIFORNIA, ON FEBRUARY 18-19, 1969. VOLUME 1

Federal Water Pollution Control Administration
San Francisco, California

19 February 1969

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# CLEAN WATER

## ....FOR THE NATION'S ESTUARIES

PROCEEDINGS
PUBLIC MEETING
ON
WATER QUALITY MANAGEMENT
FOR ESTUARIES
SAN FRANCISCO, CALIFORNIA
FEBRUARY 18-19, 1969
VOLUME 1 OF 2

March 3, 1849

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FEDERAL WATER POLLUTION CONTROL ADMINISTRATION • U. S. DEPARTMENT OF THE INTERIOR
PACIFIC SOUTHWEST REGION SAN FRANCISCO, CALIFORNIA

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# PROCEEDINGS

## PUBLIC MEETING

## ON

## WATER QUALITY MANAGEMENT FOR ESTUARIES

VOLUME 1 OF 2

STATE OF CALIFORNIA

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

February 18-19, 1969

State Office Building
San Francisco, California

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# CLEAN WATER ....FOR THE NATION'S ESTUARIES

## INVITATION

### PUBLIC MEETINGS ON WATER QUALITY MANAGEMENT FOR ESTUARIES

As a cooperative endeavor, the California State Water Resources Control Board and the Federal Water Pollution Control Administration will co-sponsor two state-wide estuarine public meetings in February 1969. The meetings are scheduled for 9 a.m. at the following locations, on the dates listed:

San Francisco, California February 18-19, 1969

Room 1194
State of California Building
350 McAllister Street
San Francisco, California 94102

Los Angeles, California February 25-26, 1969

Room 1138
Junipero Serra Building
State of California
107 South Broadway
Los Angeles, California 90012

Under mandate of Congress, the U. S. Department of the Interior, Federal Water Pollution Control Administration is responsible for the preparation of a comprehensive report on the status of pollution in the Nation's estuaries. The report will include:

1. an analysis of the importance of estuaries to the economic and social well-being of the people of the United States and of the effects of pollution upon the use and enjoyment of such estuaries;
2. a discussion of the major economic, social and ecological trends occurring in the estuarine zones of the Nation; and
3. recommendations for a comprehensive national program for the preservation, study, use and development of estuaries

of the Nation, and the respective responsibilities which should be assumed by Federal, State and local governments and by public and private interests.

These public meetings will provide an opportunity for individuals, groups, associations and organizations having an interest in the estuaries in the State of California and the problems related thereto, to make their views known.

Presentations may be either written or oral. If written, three copies, preferably typed, should be available for the record. An oral summary of the statement may be given at the meeting if so desired. Those anticipating presentation of statements, or if additional information on the meetings is needed, should call or write:

Mr. Irving M. Terzich
Pacific Southwest Region
Federal Water Pollution Control Administration
760 Market Street
San Francisco, California 94102     Phone: (415) 556-7637

by February 12, 1969, to facilitate adequate time scheduling for presentations. Written statements for the record will be accepted until March 14, 1969.

To accommodate the greatest number of participants, meeting sessions will be planned for the morning, afternoon and evening of the first day. If the volume of presentations warrants, the morning of the second day will be scheduled to hear additional statements.

Attachments
1. Guidelines for Public Meetings
2. National Estuarine Pollution Study

# CLEAN WATER ....FOR THE NATION'S ESTUARIES

## GUIDELINES FOR PRESENTATIONS AT PUBLIC MEETINGS ON WATER QUALITY MANAGEMENT FOR ESTUARINE AREAS
## STATE OF CALIFORNIA

| | |
|---|---|
| San Francisco, California | February 18-19, 1969 |
| Los Angeles, California | February 25-26, 1969 |

The estuary system of California includes its tidal waters, the shore and adjacent land, and the biology and ecology of the coastal areas. It is this total resource on which we wish to receive information at the February 1969 public meetings.

We will be particularly interested in your answers and position on the following types of questions:

What are the values (aesthetic, personal, recreational, dollar, etc.) of an estuary?
How have they been damaged by pollution, and how much?
What do you think the future of our coastal zones should be?
What are the best uses of our estuaries?
What system of management--local, State and Federal--will best provide for development and protection of our estuarine resources?

You may have other pertinent points to raise. We are interested in hearing what you have to say on the subject of pollution, its effects, and its control in our estuaries.

To provide for an orderly meeting with time available for all, the following guides are established:

1. Statements should be concise and based upon the subjects of estuarine pollution and its effects on beneficial uses. It is suggested that lengthy statements be filed in writing for inclusion in the meeting record, and a brief summary of the statement presented orally.

2. A screen, blackboard, easel and projection equipment (2" x 2" 35 mm slides) will be provided for those wishing to accompany their presentation with visual aids. Special visual aids will be the responsibility of those making presentations.

# FOREWORD

The public meeting transcript which follows is an important part of the National Estuarine Pollution Study. In the Clean Waters Restoration Act of 1966, Congress directed the Secretary of the Interior to conduct a study of the Nation's estuaries and to submit a report thereon by November, 1969. The report is to include recommendations for a comprehensive national program for the preservation, use and development of the estuaries; and the respective responsibilities which should be assumed by Federal, State and local governments, and by public and private interests. Jointly sponsored by the State of California and the Pacific Southwest Region, Federal Water Pollution Control Administration the meeting provided an opportunity for all interested individuals and organizations to express their views on water quality management for the estuaries of the State of California.

...The Hearing was called to order at 9:15 a.m. ...

MR. McCARTY: Good morning and welcome to your meeting.

My name is James McCarty, and I am Coordinator for the National Estuarine Study in the Pacific Southwest Region of the Federal Water Pollution Control Administration.

Mr. Paul DeFalco, Director for the Pacific Southwest Region, Federal Water Pollution Control Administration, has asked that I express his deepest regrets at being unable to preside at this meeting. As many of you know, our Agency has been involved to a considerable extent in the oil pollution problem at Santa Barbara, and it has been necessary for him to attend to important matters related to this situation.

The purpose of this public meeting is to receive your views on the impact of pollution on California's estuarine system. Certainly, in this State, perhaps more than any other, these waters are among your most priceless resources.

This public meeting is the first of two being planned for the State of California. The other meeting will be held next week in Los Angeles. To date, meetings such as this have been held in 23 coastal states of the Nation.

In a few moments, you will be asked to express your views on this important subject and you will be presenting them to Mr. Alexander and myself.

We are not here to judge or cross-examine. We wish to hear and to understand what you have to say. Occasionally, Mr. Alexander or myself may ask questions of the speaker to clarify a point or to guide discussions to bring out particular views on an important issue. Debate of issues is not a proper function of this meeting.

I would like to have you meet Mr. William Alexander, my Co-Chairman for this meeting, now.

MR. ALEXANDER: Thank you, Mr. McCarty. I am William Alexander, Vice-Chairman of the State Water Resources Control Board, and on behalf of Kerry Mulligan, the Chairman of the Board, and the rest of the Board Members, I am happy to welcome you all here today. We are certainly interested in your testimony, information that you have for the group here and are glad to be a part of this public meeting.

Thank you.

MR. McCARTY: Thanks, Bill.

Many of you have read our announcements regarding this meeting and are familiar with our study. For those of you who are not, I would like to call on Mr. Irving Terzich, of our Regional Staff, to present a brief statement on legislation related to the study and activities to date. Mr. Terzich.

MR. TERZICH: Thank you. I am Irving M. Terzich, Public Information and Education Director, Pacific Southwest Region, Federal Water Pollution Control Administration.

The National Estuarine Pollution Study was authorized by the Congress through passage of the Clean Water Restoration Act of 1966. This Act directs the Secretary of the Department of the Interior in cooperation with many public and private interests to conduct a comprehensive study of the Nation's estuaries. Specifically, this study will:

Determine the present state of pollution

Delineate pollution problems requiring further study

Evaluate the effects of pollution on beneficial uses

Document the values of estuarine zones

Provide a basis of action for the beneficial management of the Nation's estuaries.

There are many definitions of an estuary. The Federal Act has defined the term "Estuarine Zone" for purposes of this study as,

> "An environmental system consisting of an estuary and those transitional areas which are consistently influenced or affected by water from an estuary such as, but not limited to, salt marshes, coastal and intertidal areas, bays, harbors, lagoons, inshore waters and channels...."

The Act further defines the term "estuary" to mean,

> "All or part of the mouth of a navigable or interstate river or stream or other body of water having unimpaired natural connection with the open sea and within which the sea water is measurably diluted with fresh water derived from land drainage."

Thus, for purposes of this study, we are really concerned with all coastal and estuarine waters, the land areas which might affect these waters and the total management of these land and water areas.

The study is to be completed and a report made to the Congress by November of this year.

The responsibility for coordinating the study and preparing a response to Congress was assigned to the Federal Water Pollution Control Administration. The Act specifies that the report to the Congress must include, and I quote. "Recommendations for a comprehensive National program for the preservation, study, use and development of the Estuaries of the Nation; and the respective responsibilities which should be assumed by Federal, State, and Local Governments and by public and private interests."

We are using a three-pronged approach to accomplish this effort.

First, the estuaries themselves are being examined. A description of the national system is being composited in terms of what it is, how it functions and how it has been damaged by pollution.

Next, the social and economic pressures on the estuarine system are being studied. Resource use and the economic and social value of each use are being documented to establish the relative importance of these factors to the estuarine system.

The first two phases will provide an estuarine register--a comprehensive inventory--a necessary base for any management plan.

This brings us to the third phase--the development of recommendations for submission to the Congress. This is a most important phase and must include the needs and desires of the public. This is the primary reason we are gathered here today. Your remarks will be recorded in an official transcript from which recommendations will be prepared on all of the important environmental, social, economic and political factors. In essence, a management plan will be developed, describing the Nation's estuaries and proposing a management system, including the necessary authorities and responsibilities for their wise use and development.

This ambitious task, of course, cannot be done in any single Federal office. Its success requires that we seek help, advice and the counsel of others. Each Federal agency involved in estuarine work is providing us with detailed descriptions and comments. Likewise, each State is providing similar descriptions and comments.

For those aspects of the study requiring special competence and staff not available within the Administration, such as ecology, social and economic values and sedimentation, we are contracting with other agencies and organizations to provide the needed inputs. Also, very importantly, we are working closely with the coastal states. Here, we are working with the State of California. Through the cooperation and assistance of Mr. Norman Livermore, Administrator, The California Resources Agency; Mr. Kerry Mulligan, Chairman, California Water Resources Control Board; and Mr. Paul Bonderson, Chief, Division of Water Quality, of that Board, and their respective staffs, we have already contacted other State agencies and have obtained a consolidated description of California's programs related to estuary management and development. This description is now undergoing a final review by various State agencies. An additional part of their support is co-sponsorship of today's meeting.

This meeting provides an opportunity that should not go unheeded. Congress has asked for recommendations before it legislates, and it is important that your views be made known.

Thank you.

MR. McCARTY: Thank you, Irv.

I would like to make a few last remarks regarding our procedures before we begin. With the assistance of the California Water Resources Control Board, over 1400 invitations have been sent to all organizations, agencies, industrial and agricultural concerns and individuals that we thought might have an interest in this study. However, this is a public meeting and I want to emphasize this fact, and we welcome statements from anyone wishing to speak. If you have not already done so, I would ask that you please indicate on the registration cards provided at the rear of the room your desire to make a statement.

We have made arrangements to convene the meeting this evening to receive statements beginning at 7:00 p.m. for those of you who cannot stay through the day. If the volume of presentations warrant, we will reconvene again tomorrow morning beginning at 9:00 a.m. If you have questions about making your statement, please ask Mr. Terzich to help you. He will generally be located in the rear of the room at the registration desk.

Those of you wishing to submit written statements either now or in the next few weeks are welcome to do so. Mr. Terzich will take them or tell you where they can be mailed. Any written statement submitted by March 14 of this year will be included in the record.

We have a 35 millimeter slide projector available for those of you who need it, and you simply have to indicate to Mr. Terzich if you would like to use it.

These proceedings are being recorded and a verbatim transcript is being made which will provide a complete record of what is said here today. We will make copies of it available to the State Water Resources Control Board -- California's official water pollution control agency. We have found that generally it is best that the people who wish transcripts should request them through their State agencies rather than directly from the Federal Government. This maintains a normal relationship of the people with the State. However, for those of you who would like a copy, please enter your name and address on the cards provided at the rear of the room.

If you are planning to speak and have a written copy or outline, it would greatly aid us if you would provide Mr. Terzich with a copy before making your statement. Also, if you have exhibits or any maps that you would like included in the transcript, please remember that everything in the transcript will be in black and white. It would help if anyone using a visual aid will try to remember that your statement will appear in transcript form and avoid saying things like "over there" or "the spot marked in red." Otherwise, your statement in the transcript may end up being relatively unintelligible. People who are making a statement should come to the lectern here in front.

Once again, let me emphasize that we are not prepared to entertain questions from the floor. Our purpose is to collect your views and ideas and not to provide a forum for debate.

I would like to now call on our first speaker of the morning. I understand that Congressman Mailliard is in the audience. Congressman William S. Mailliard from the Sixth Congressional District, State of California, we welcome you here today.

CONGRESSMAN WILLIAM S. MAILLIARD: Mr. McCarty and Mr. Alexander. My only purpose in being here today is to express my very deep and long-term personal interest in this kind of a project. As a member of the Committee on Merchant Marine Fisheries, we have been wrestling with these problems now for a number of years, and finally last August, a bill that came from our Committee was signed into law which tied in very specifically to the responsibility that had already been placed on the Federal Water Pollution Control Administration to expand their study to include a little bit broader spectrum than just the question of pollution.

The Committee hearings which were quite extensive and were published represent quite a volume and have a lot of information, but there again, mostly from Government agencies, not too much from the public, and I just think that this is the right way to go at this kind of a problem so that everybody gets a chance to have their say, and it is very comforting to me to see the rather new, I'm afraid, public interest in what I consider to be one of our major problems.

It seems to me that this question of managing our environment and resources is just as much a matter of life and death as the atomic bomb or almost anything else we can think of, and neglect is certainly apparent to anyone who has lived here in the Bay Area for half a century like I have where I can remember resources in this Bay that simply do not exist anymore. I am afraid that we are moving further down that path.

As a matter of fact, in the testimony before our Committee, we are cited as the horrible example. There are two recent reports within the last month that have been furnished to the Congress. One is from the National Marine Council on Resources and Development, and the other is from the Commission which was created by legislation on Marine Science Engineering and Resources. Both of these mention San Francisco's Bay as the horrible example of the tremendous loss over a period of twenty years or so in the tidal wetlands that were the basis of important resources both economically and from the point of view of recreation and everything else living in the area.

So, I just wanted to say to those that are here that there is a tremendous interest in the Congress in this problem and in related problems. The whole emphasis that we are trying to put on oceanographic problems all ties in together with learning how to manage our resources, and I was very interested to see that the Commission has come up with some very specific recommendations on joint State-Federal management and application of resources to try to reverse the trend that has unhappily been on us so long. As I say, I came only to express my interest in the hope that these public hearings will really produce the information that we need to proceed intelligently in the Congress to try to lick these problems.

Thank you.

MR. McCARTY: Thank you, Congressman Mailliard. We certainly appreciate your taking time from your very busy schedule to be with us this morning.

Are there any other Federal legislators, Congressmen, in the audience or their aides or representatives who would like to speak?

If not, are there any representatives from the State Legislature or their aides who would like to say some words?

If not, we will move along to our next scheduled speaker, Mr. Joseph Bodovitz, Executive Director of the San Francisco Bay Conservation and Development Commission.

MR. JOSEPH E. BODOVITZ: Thank you very much, Mr. McCarty and Mr. Alexander. I appreciate your giving me an opportunity to appear early because of a commitment that I have later on today.

As I believe you know, the San Francisco Bay Conservation and Development Commission was created by the State Legislature in 1965 as a result of public concern in the Bay Area over unrestricted filling of the San Francisco Bay. The Commission was given two jobs to do: First, to control all filling and dredging of the Bay during a temporary period, and secondly, to prepare a plan for the future of the Bay.

The Commission has been on time with its assignments and has committed to the Governor and the Legislature in the last month its plan for the Bay, together with a summary. I mentioned this because both of these documents are available to the public for sale at cost from the State Printing Office in Sacramento. If anyone is interested, I can provide details as to that.

I would like to submit for the record a very brief summary sheet outlining the Commission's findings and conclusions in its plan that I hope would be of use as part of your record.

The Chairman of our Commission, Melvin Lane, Publisher of SUNSET Magazine, expresses his regrets at not being able to be here today and has asked me to outline a couple of the prime conclusions of the plan. As I said, the Commission was formed over concern for Bay filling but has naturally, as part of its work, worked very closely with the water pollution and water quality agencies, both State and Federal, and the level of the conclusions are for the Bay to provide all the public benefit it can in the future, water quality must and can and should be maintained at a suitable level that will permit widespread recreational use of the Bay and sufficient habitat for all the species of marine life we deem necessary to keep.

We believe, as I say, that this can and should be done. We have not dealt with this in detail because of the many agencies concerned with the field of water quality, but we have all been educated by the Regional Water Quality Control Board and the technicians in the field of water quality to understand that every time a bit of fill goes into the Bay, for whatever purpose, it is very important.

As many of you have heard from the statistics, at the time of the Gold Rush, the Bay included in total something like 680 square miles in area. Now, as a result of man's diking and filling, the activities Congressman Mailliard described, the total system of the Bay is down to not more than 400 square miles.

If all parts of the present Bay less than 12 feet deep were to be filled -- all the parts described by the U. S. Army Corps of Engineers as "susceptible of reclamation" -- the Bay would consist of only 187 square miles. In some places it would be little more than a river.

We have become impressed not only with the need for high water quality for recreation, but with increasing emphasis on agricultural or mariculture or, that is, the use of coastal estuaries to increase plant and marine life as a method of feeding the world's growing population. While this idea is at an early stage, it is receiving increasing attention as a very real possibility and one, of course, for which San Francisco Bay might well be ideally suited, provided water quality can be maintained at a suitable level.

To go on to explain the relation of this to Bay filling, of course, if the shallow parts of this Bay are paved over for other purposes, then this very important potential use of the Bay would be lost.

Let me conclude by saying I noticed in the announcement of the meeting that you were primarily interested in thoughts on management of coastal estuaries. It would appear to us that this is really the heart of the problem. I mentioned our Commission was created by the State Legislature. It is a unique body of the country in that it is made up of representatives of Federal, State and local government.

The Welfare Department serves as full voting members of our Commission because of Federal statute. They do not vote on fill planning and other activities of the Commission. In addition, we have worked closely with the Department of the Interior and the Housing Urban Development Department, but, as I say, we have representatives of all levels of government taking part in this agency, and we have also been told that the kind of planning we have done and the kind of agency that has done it is really unique in its conclusion and our findings and our methods of use to other people.

It seems to me -- I'll express a personal opinion here -- the managing of estuaries is really the heart of the problem. To overstate the case, I would say that our problems are ten percent research. I assume the researchers in the audience will have time for rebuttal.

Our crucial decisions are to act sensibly on what we already know, and it seems to me we are not yet doing that. These factors are much on our minds because our Commission under present law will expire 90 days after the California Legislature adjourns this year and, therefore, crucial decisions as to the future of San Francisco Bay will be made in Sacramento during this session of the Legislature.

Our Commission is proposing that there be some kind of permanent regional agency able to control all filling and dredging in the Bay from now on out in accordance with the provisions in our plan. The heart of the Commission's planning is that the Bay can be made more useful. It can provide much more in the way of public benefits than it now does, and in some few instances, filling will be necessary to achieve this, but that all the water-related needs providing public benefits can be satisfactorily met without substantially diminishing the Bay. At the same time, the public responsible regional agency is needed, too.

We have proposed that this can be done in many of several ways -- either an elected regional government or a continuing agency such as ours. This is a matter naturally requiring political decision and political determination. The Commission's decision is essentially that the Bay is as big now as it will probably ever be and what is needed is a permanent responsible management to see that when our children and grandchildren have reached the age of those of us in this room today that the Bay will still be here.

The Bay does many things and serves many functions. I emphasized recreation. The Bay is, of course, one of the greatest harbors in the world, and around it are sites, many of which are important to the economy of the Bay region, so it is extremely important all these water-related uses be balanced and that the public interest consider all these aspects of the Bay.

We do not believe there is any magic. We do not believe there is any computer. We do not believe there is a problem. Therefore, we would emphasize that the heart of what is needed certainly for San Francisco, and I would assume other coastal estuaries as well, is some kind of politically accountable economic development, recreation, wildlife, natural beauty. All of these values can be taken into account and a sensible system of management can prevail.

I think I have gone on longer than I should. I appreciate the opportunity to be heard.

MR. McCARTY: Thank you. Do you have any questions, Bill?

MR. ALEXANDER: I had one question. Your organization primarily is concerned then with the filling and the dredging of the Bay?

MR. BODOVITZ: Yes, sir, that is correct.

MR. ALEXANDER: That is where your efforts have been -- along that line?

MR. BODOVITZ: Yes, sir. Well, we have worked closely with the water quality agencies. We have no legal responsibilities or powers in this field. There is, in other words, no overlapping here.

MR. ALEXANDER: Did you work on the San Francisco Bay studies to some extent?

MR. BODOVITZ: The Bay Delta?

MR. ALEXANDER: Yes.

MR. BODOVITZ: We worked very closely with the Bay Delta, and we were represented on some technical and advisory committees. That was a separate study.

MR. ALEXANDER: Thank you.

MR. McCARTY: Mr. Bodovitz, you mentioned that your report makes some recommendations, I believe, about the management of San Francisco Bay. Does this include management of things other than the filling and dredging of the Bay?

MR. BODOVITZ: Yes. The Commission concluded that in the long run sensible management of the Bay will require some limited controls over what happens in the zone immediately around the Bay, and the Commission therefore, had the two types of recommendations. First, with regard to the salt ponds, the large areas particularly at the south end of the Bay in which salt is harvested by evaporating the Bay water. These areas are diked off from the Bay, but they are important to the ecology of the region for two reasons. One is wildlife habitat -- that some of these be acquired as wildlife habitats.

Even more important is the fact that these salt ponds have an effect on climate. The meteorological consultant to our Commission has stated in a report written for our Commission a couple of years ago that if as much as 25 percent of the present water surface, including the Bay waters and the salt ponds, were to be filled, there would be noticeable rises in temperature in the San Jose area.

This is based on obviously incomplete research, and this is one area where more research is needed. The further studies made in the intervening two years shows the importance of this large water surface in moderating climate and combating smog. For this reason, the Commission has recommended that the salt production be continued.

If, for any reason, the salt industry wishes to close these salt ponds, then the public should make every effort to buy these lands and open them to the Bay.

If development is permitted in the salt ponds, it should be regulated in such a way as to leave as much open water as possible. That is, whatever development there is should be intensive on a relatively small amount of fill with as much left open as possible.

The second area is the existing land. The Commission has recommended here that certain areas which we have called priority areas, ports, industries, airports -- whatever -- be subject to a limited amount of regional jurisdiction to provide that as long as these areas -- let me back up a minute -- that if an area is suitable for port use, it either stay in that use or the regional agency have the right to say it is no longer needed for that purpose.

The concern is that if a port agency or a water-related agency sells off part of its land for houses or supermarkets, there is at least a concern that a few years hence, the same agency may be back and say we need the land. The concern is here that the regional agency be able to keep a running inventory of the best and water-related industry land and so forth.

If an area is no longer needed for that purpose, it could concur. Otherwise, it would have the right to say it ought to be retained for that purpose.

MR. McCARTY: One other question. Relating to your recommendations regarding the regional agency, do you have any feelings or does your report suggest generally the relationship of the local people, city and county government, state government and federal government in this regional agency?

MR. BODOVITZ: Our Commission was initially directed by law to recommend the kind of agency that should carry out its plan. Subsequent to that, however, the Legislature created a joint committee, that is, Committee of Senators and Assemblymen, a Bay Area Regional Organization, and gave it -- that joint Committee --

the primary responsibility for making recommendations in the area of regional organization and directing us to cooperate with them, but not to proceed with further studies.

Our Commission did so, and our recommendations, therefore, are twofold: First, we have recommended to that joint committee that if an elected regional government or regional agency with more than one kind of responsibility is created in the Bay Area, then control over Bay filling and dredging would be a logical responsibility for that agency. We have said if there is a regional agency created in the Bay Area, we believe at least a sizable portion of its governing body should be elected, although the rest could be appointed.

Secondly, we have said if for any reason such an agency is not created, then an appointed agency perhaps such as ours should be continued. By "such as ours", I think the Commission meant all levels of government.

I think one of the things -- again a personal opinion here -- I think one of the reasons this kind of planning has worked has been that all levels of government and the public have been represented as voting members of the Commission. There are many people who believe that there is an untidily large number, 27, and it ought to be reduced to five or seven or nine, and we always ask these people how they would choose the five, seven or nine, and everybody agrees that might be a good idea, but it is pretty hard to see how five, seven or nine people are going to fairly represent everybody who wants to be represented.

The Bay Area has four and a half million people, which is a population larger than 35 of the states in the country, and I do not think having a large governing body is out of keeping with that kind of complex environment we live in.

MR. McCARTY: I think your efforts are unique in the country in this particular kind of a study, and we are particularly interested in getting your views or expression of your views on the management or using this particular management approach in other parts of the country where estuaries are.

My last question would be whether or not you feel these approaches might be suitable in other locations?

MR. BODOVITZ: I would see no reason why the general principles we have tried to follow would not be suitable in other locations. We have one advantage here that many other estuaries do not, and that is that San Francisco Bay is located entirely within one state. My limited experience in talking to people from other areas is that when several states are involved and interstate compacts are required, there are automatically more political and governmental problems presented.

I have been involved with some people in at least two such estuaries, and I have not really seen why once that problem is licked the same principles should not apply.

MR. McCARTY: Thank you, Mr. Bodovitz.

I would like now to call on Mr. Trevenen A. Wright with the California Department of Fish and Game who wishes to make a statement.

MR. TREVENEN A. WRIGHT: Mr. McCarty, Mr. Alexander, Ladies and Gentlemen. It is a pleasure to have this opportunity to appear before you today to present our observations on the estuarine resources of California. In addition to this oral presentation, we will submit a written statement with more specific comments for the proceedings of these hearings.

By law, the California Department of Fish and Game is charged with the protection, maintenance and enhancement of all of this State's fish and wildlife resources. Whether we succeed or fail will largely depend on whether we can protect and maintain the habitat our fish and wildlife must have if they are to survive.

In the Department's Fish and Wildlife Plan, developed in 1965, we have identified the loss of coastal wetlands, including bays, estuaries, marshes, sloughs and lagoons as being one of the major problems of fish and wildlife today. This loss of habitat is the result of a number of man's activities in the estuarine environment, all of which could be classed as pollution in its broadest sense. Such activities include dredging, filling, construction of marinas, residential and industrial development and deposition of wastes, all of which alter the natural environment and in most instances are detrimental to the fish and wildlife dependent on that environment.

I could continue to point out the problems of our fish and wildlife resource estuary by estuary; however, during the course of this hearing and the hearing to be held in Los Angeles, I am sure most of the estuarine problems will be identified. Rather than belabor the problem aspects of the estuarine situation, let's look at the other side of the coin and see what actions are being taken to preserve our estuarine environment.

It is gratifying to see that in the last several years the public and people at all levels of government have become aware of the value of our estuarine resource and are now doing something to preserve it.

The following are some of the actions taking place on the State level where the California Department of Fish and Game is involved.

1. The passage of the Marine Resources Conservation and Development Act of 1967 by the California Legislature calls for the development of a comprehensive ocean area plan which includes the estuarine areas. The Interagency Council on Ocean Resources is now in the process of preparing this plan. The Department of Fish and Game, through the Resources Agency, will be a major contributor to this plan.

2. The passage of the Protected Waterways Act by the California Legislature in 1968 requires an inventory and identification of those waterways having outstanding scenic, fisheries, wildlife and recreational values and to recommend measures for their protection. The definition of a waterway includes bays, estuaries, lagoons, marshes and wetlands in addition to streams and lakes. The Resources Agency is now implementing this Act and is scheduled to make its first report to the Legislature by January, 1971.

3. The establishment of the San Francisco Bay Conservation and Development Commission by the Legislature in 1965 has provided a planning effort that will materially guide the future use of San Francisco Bay for the benefit of all the people. The Department of Fish and Game has been a major contributor to the Commission's plan which has been recently published, as was shown to you by Mr. Bodovitz.

4. As an adjunct to the BCDC effort, the Legislature established the San Francisco Bay-Delta Water Quality Control Program in 1965. The Department of Fish and Game as one of the agencies assigned to the study, has completed its portion of the study. When the final report is submitted to the Legislature in a few months, it will include recommendations to maintain water quality to insure and enhance the fish and wildlife environment.

5. The Department has been working with the Federal Water Pollution Control Administration providing input for their efforts under the Clean Water Restoration Act of 1966. A report was submitted in 1967 on the major estuarine areas.

6. The Department is now working closely with the U. S. Fish and Wildlife Service and providing input for the studies being carried on under Public Law 90-454 the National effort on estuarine studies.

7. We are also working with the military installations under the "Sikes Act." A number of fish and wildlife plans have

been drafted for military reservations along the coast. These have emphasized the importance of the proper management of estuarine resources on these bases. A good example is the excellent cooperation we have obtained in planning estuarine habitat restoration on Camp Pendleton in San Diego County.

8. In early 1968, the Department of Fish and Game began a Bay and Estuary Study and Planning Program. Intensive ecological studies are now being carried out on eleven estuarine areas--Humboldt Bay, Eel River Delta, Bolinas Lagoon, Tomales Bay, Elkhorn Slough, Morro Bay, Goleta Slough, Mugu Lagoon, Anaheim Bay, Upper Newport Bay and Los Penasquitos Lagoon. These were given highest priority based on threat time to fish and wildlife values and the possibility that they might still be preserved.

The Department of Fish and Game's Bay and Estuary Study and Planning Program includes the documentation of fish and wildlife values and the present and projected use and demands of the estuarine resource. This information in turn will be presented to those responsible for planning, development and utilization of this resource.

To further document the value of the estuarine resource, we began a shorebird study in 1968 on a statewide basis. Once we have determined the exact needs of the birdlife now living in our coastal wetland areas, we will be in a much better position to tell the planners exactly what habitat should be saved to maintain the species.

The Department of Fish and Game has been working closely with the regional Water Quality Control Boards in recommending water quality standards. Presently, water quality standards are being revised and in most cases raised. However, these standards must be enforced and penalties must be severe enough so that it will not be profitable for any group to pollute the State's coastal waters.

The Department is increasingly active in studying the effects of various kinds of pollution in coastal waters. A team of professional diver-biologists has made studies of a number of outfall sites, such as sewers and power plants and has accumulated considerable information on the "before and after" situation relating to these outfalls.

Another important action program is being carried out by the Department through the Wildlife Conservation Board, which is a capital outlay source having State funds in the form of $750,000 annually derived from the State's horseracing revenues and Federal funds from a portion of the Land and Water Conservation Fund Act. The Wildlife Conservation Board has been and is active in the acquisition of coastal areas for public access, recreation and key ecological areas important for coastal fish and wildlife.

The data we are gathering in our studies and investigations is essential if we are to make factual, sound recommendations in carrying out our responsibility as a Department to conserve, manage and enhance the living fish and wildlife resources and environment. We must obtain more knowledge about the estuarine resource as soon as possible in order that present and proposed modifications of the environment may be properly assessed.

Documented data on fish and wildlife values and human use and demand will provide the information needed by the public and those agencies who are determining and planning for the utilization of our estuarine resource. We are also confident that without this information the wildlife resource will not be given due consideration as has been largely the case to date.

Lastly, we are thankful and encouraged by the many citizens, individually and in groups, who are actively working to preserve these valuable coastal wetlands in California. We are aware as I am sure most of you here are that they are the moving force that influences the legislature and the State and local agencies to carry out needed actions.

Thank you very much.

MR. McCARTY: Mr. Alexander, do you have any questions?

MR. ALEXANDER: Yes. I had one question as to right in the beginning you were talking about this Resources Development Act of 1967. You are proceeding with the plan at the present time. When do you plan on having that completed?

MR. WRIGHT: I am not sure they have set a date yet on the planned completion. I know they have outlined it. I will have to get that information for you.

MR. ALEXANDER: Your Department is only contributing a part to this overall plan?

MR. WRIGHT: Right.

MR. ALEXANDER: You are putting input into it, and others are contributing also?

MR. WRIGHT: Right, ours is just one agency of several that are involved in this overall study.

MR. ALEXANDER: You plan to have the initial report in 1971 through the Resources Agency; do you know how long that study is to be?

MR. WRIGHT: Its first report would be to the Legislature in 1971, and I suspect it will have recommendations to perhaps continue with some additional studies and recommendations that will come out of this first report. I am not sure just how long it will extend.

MR. ALEXANDER: Thank you for the statement.

MR. McCARTY: I also wanted to thank Mr. Wright and his Department for the tremendous amount of assistance they have provided us in developing a statement profile for the State of California for the various state activities in the areas of estuarine management and control. His Department did an excellent job in providing information along these lines.

I have one question, Mr. Wright, regarding your relatively new program -- the Bay and Estuary Study and Planning Program. I assume this is a Department program rather than a legislatively directed program; is that correct?

MR. WRIGHT: That is correct.

MR. McCARTY: And would this be a continuing program? Do you have an organization or some sort of setup?

MR. WRIGHT: Yes, we have assigned this to our regional people in the Department, and as soon as we complete these major ones I mentioned, we expect to continue and complete the studies on our bays and estuaries up and down the Coast.

We will also be working on others than those that I have mentioned if a situation comes up -- a critical situation.

MR. McCARTY: But this would be a continuing planning effort that would result in a series or stream of reports on various kinds of problems and recommendations rather than terminating a specific date; is that correct?

MR. WRIGHT: Right.

MR. McCARTY: And how do you get the results of these studies into the various planning agencies -- through the publishing of reports?

MR. WRIGHT: Yes, we will publicize our reports, but we will also be involved with the local planning agencies in the area and work with them and make sure whatever planning agency is going ahead with the job is aware of our report and aware of our studies that will fit into the overall planning.

We have done this on the report on Morro Bay. We have made this report up, and it is now in the hands of the local planning agency.

MR. McCARTY: Thank you, Mr. Wright.

Next, I would like to call on Mr. Sidney Brooks who represents the Association of Monterey Bay Area Governments. Mr. Brooks.

MR. SIDNEY BROOKS: Mr. McCarty, Mr. Alexander, Ladies and Gentlemen. I will be very, very brief this morning. I have little more to say than to read the purpose of the Association of Monterey Bay Area Governments. It is composed of governmental agencies concerned with the pollution of waters of Monterey Bay and its tributaries and its retention as a natural asset for commercial and recreational purposes.

This organization is concerned with one of the few relatively unpolluted bays left on the California Coast. Its concern is a civic concern. The organization was started almost three years ago. It has been operating in full force for approximately a year, and it is an amazing organization in that it is a purely voluntary organization operating under a joint power agreement.

Cities and counties of the three counties, Santa Cruz, Monterey and San Benito Counties, which essentially share the same watershed fronting on Monterey Bay, have joined together to prevent the further pollution of the Bay.

The sole purpose of the Association is to make studies, findings and recommendations concerning pollution of the waters of Monterey Bay. At the present time, the Association is preparing a proposal for a major study of the dynamics of the Bay, a determination of the sources of pollution existing, the probable future sources of pollution, both from within our own watershed and from other possible sources, and an evaluation of the assets and the relative priorities to be established for the utilization of this tremendous asset of Monterey Bay.

The Association intends to submit a formal statement within the next two weeks.

MR. McCARTY: And would you like that to be a part of the transcript?

MR. BROOKS: Please.

MR. McCARTY: Thank you, Mr. Brooks.

I would next like to call on John P. Harville with the Moss Landing Marine Laboratories, California State Colleges.

DR. JOHN P. HARVILLE: Thank you, Mr. McCarty and Mr. Alexander. I appreciate also being early on your agenda today as I have some other commitments I must get to. I am also pleased to be able to follow comments from two regional agencies, Joe Bodovitz of BCDC, and Sid Brooks of the Association of Monterey Bay Area Governments. I think these two illustrations of community action that have been presented do show the kind of grass roots concern for our resources which have rather lately come upon us and represents a very important trend for the future.

I think it is also very heartening that the remarks of Congressman Mailliard could have come early in this meeting pointing out the absolute necessity of consideration of many aspects of human encroachment upon the oceans rather than pollution alone in, let's say, a narrowly conceived sense.

On behalf of the Moss Landing Marine Laboratories, California State Colleges, I have submitted a written statement which documents in some detail recent actions in the State of California leading toward an action program for protection and wide use of bays and estuaries.

The Moss Landing Marine Laboratories are particularly concerned with this matter since we are located near the mouth of Elkhorn Slough with estuarine conditions which make this an ideal location for destruction and research in the marine sciences.

Incidentally, I want to interpolate one other comment: I noticed Joe Bodovitz mentioning a certain amount of confidence in large groups' management. I think many of us who have been in the field of management procedures for some years have a certain amount of concern for groups being too large. There is an assumption if you want a job done right, you have a one-man committee do it. The smaller the committee, the action takes place quicker.

May I support strongly the importance of large group functions if they are well planned in such areas as the public concern for a resource. I have been associated with the BCDC group as a member of an advisory committee for some years, and I would endorse in terms of our concern for management the efficiency of a large group broadly representative of interested agencies.

I add this note for another reason: The Moss Landing Marine Laboratories which I represent are a creation of five separate sovereign institutions -- five California State Colleges -- and we placed with some trepidation a large group in management of that organization -- a policy board with representation from each college. I submit for the record that this will work if it is properly conceived and the people really have a sort of vital interest in the task at hand that is evidenced by the groups I have used as examples.

I would like to talk briefly about the values of estuaries, and I would like to add certain crux to these values and highlight some of the more pertinent actions of the last few years that have not so far been mentioned in today's meeting which implement a program of estuarine protection. Finally, I would like to make some comments for consideration of optimum use of these scarce resources.

In terms of primary values of estuaries, the National Estuarine Pollution Study accepts certain premises concerning value as expressed under "Frame of Reference" in the March, 1968, Summary Booklet. Many of these were very eloquently restated by Joe Bodovitz a few moments ago.

I would like to speak to three points: First, I would like to say something about recent dollar value estimates for nearshore waters of California which I think are illustrative; second, I would like to document in terms of living laboratory values a specific estuary, that of Elkhorn Slough and Moss Landing, as an outdoor laboratory for educational and scientific research purposes; and third, very briefly to comment on particular ecological significance of the shallow water areas of estuaries -- again a point that Joe Bodovitz made earlier.

Bill Clarke of Westinghouse Ocean Research Laboratory in September of 1967 produced an interesting assessment of uses and values for California's nearshore environment. He identified, subdivided and briefly analyzed five classes of uses of the nearshore waters. These classes were recreational which includes fishing, boating, swimming, camping, and so on; commercial which includes the fisheries, kelp harvesting, oil, salt, harbor development; scientific which includes education and research and developmental functions; waste disposal, and this includes domestic, agricultural, industrial sewage, garbage, thermal and saline wastes; and then he also paid some attention to some future uses not yet well established in terms of underwater habitation, the use of fresh water from the sea, aquaculture, nutrients, and so on.

Many of these actual or potential uses are directly competing, and some, of course, are mutually excluding. All must be considered in assessing the potential value of any segment of the nearshore environment. Most will figure to greater or less extent in the decision-making process for shoreline and nearshore water management.

Dr. Clarke made some estimates on the total annual value of California's nearshore waters and estimated these for the entire State in excess of one and a quarter billion dollars. More than two thirds of this value -- and this is a rather surprising figure -- he assigns to recreational use -- some 887 million dollars per year, of which tourist expenditures account for 450 million, boating 316 million, sport fishing 107 million. He evaluates commercial uses at nearly 390 million dollars, with seawater cooling for power generation accounting for 213 million of that total, oil industry 138 million, and commercial fisheries 23 million.

He estimates waste disposal at sea at 9.4 million as the value of annual savings through deposition of sewage at sea as opposed to some alternate means of handling it. May I emphasize, out of the one and a quarter billions of dollars in his estimate, he believes that some three fourths of this lies in the recreational significance of this area. I am sorry, that should be two thirds.

Now certainly, I would hope and I would very strongly urge that we never trap ourselves into making decisions only in terms of dollar values, but it is time that we began to attach economic significance to some of these things that are very hard to put dollar signs upon.

Let me turn to another aspect of values and speak in terms of our own estuary at Moss Landing, the Moss Landing-Elkhorn Slough complex with the tributary streams that flow into it. This is a rather small embayment; only a fraction of the size of San Francisco Bay. Yet, it is a priceless living laboratory which lies very close to the population centers of Central California and has ready access for students and faculties -- none more than a half hour away. There are three community colleges, three junior colleges in our area, and then four advanced institutions with four-year programs and graduate work for advance research by marine scientists and engineers.

These senior institutions cover a remarkable gamut of the educational system of this State, and indeed, of the Nation. They include the University of California at Santa Cruz, Stanford University's Hopkins Marine Station at Pacific Grove, the U. S. Navy's Postgraduate School at Monterey, and the California State Colleges' Marine Laboratories at Moss Landing. The Postgraduate School in Monterey is the only institution of its kind in the United States, providing master's and doctoral level education for Marine Naval Officers.

The facilities of Stanford and the University of California serve two illustrious university systems.

Hopkins Marine Station at Pacific Grove is the oldest facility of its kind on the Coast.

The Moss Landing Marine Laboratories provide marine science educational and research opportunities for students from five Central California colleges, operating the year around with an enrollment averaging 60.

Incidentally, those five colleges enroll a total of some 60,000, about one third of the total enrollment of the State Colleges. Recent estimates of educational and research uses of Elkhorn Slough indicate that college students invest nearly 5,000 man-days per year in support of their academic career objectives. These 5,000 man-days involve some 1200 college students. Many of these are on single-day field trips from schools outside the Monterey Bay Area, but perhaps 200 are resident students engaged in long-term studies for which the estuary is a central living laboratory. We can add another 2,000 man-days for high school student use and for elementary school use, and our conservative estimates indicate that in this one area, this use will increase by 50 to 60 percent over the next five years.

These use figures cannot be equated to dollars, nor should they be. Their significance in terms of investment in the future is truly incalculable.

I might add as a matter of the growing concern for this use that in a recent effort to retain the quality of Elkhorn Slough at the highest possible levels rather than permitting it to be degraded below those levels, the State Water Quality Control authorities were most impressed by the importance of this educational resource, the investment we have in the future of our State and our Nation in the young people we are training. The point is that this may be vastly more important in any investment than say X pounds of shellfish such an estuary may produce.

In terms of my third point, I would like to stress especially the role of the shallow waters, the marshes and the mudflats, which Mr. Bodovitz pointed out to you today, in relation to filling and diking and various types of exploitation. This is an area of concern which is obvious to the ecologist but hard to develop in the eyes of the layman who is inclined to wonder just what good is a mudflat and what we really lose by sacrificing some of it and retaining perhaps a little which will serve as a resting ground for birds and a few other things.

I have been told by those who are responsible for influencing decision making that this is one of our greatest tasks, and so as an ecologist, I must take this opportunity to stress in the strongest possible terms the critical nature of the shallow waters of an estuary in maintaining the health of that system as a living system. We might best start this consideration with the salt marshes which are extraordinarily fertile. Living marsh plants fix the energy of sunlight into their tissues through photosynthesis, and expel oxygen to the surrounding environment. Thus, primary productivity is high in the marshes.

Birds and waterfowl of various sorts and many other animals come to the marshes drawn by the lush vegetation, and they add their metabolic wastes to the system, and the decomposition of these wastes plus those of the decaying plants form the basis of a very complex food web and contribute nutrients from the marshes to the shallows of the bay margin supporting a vast marine-life nursery.

The mudflats, themselves, are converters of energy derived from nearby environments, including the marshes. In addition, their moist surface provides the habitat for highly productive minute algae.

Each ebb and flow of the tide exposes these tiny plants alternately to abundant light energy and to the high nutrient content of the shallow bay waters. Every tidal interchange injects oxygen into the water, and thereby contributes to the support of marine life and the reduction of pollution.

If we permit our estuaries to be converted to rivers, if we permit them to be degraded from our living system, then we destroy them and we create of them merely open sewers to the sea rather than elements of a living system.

Now, major threats to our estuaries are, most of them, a product of failure to perceive the multitude of long-range values in these estuaries and to plan, therefore, in a multi-purpose use for the future. Rather, we are inclined to see the short-term values, and the short-term values that can be developed from single-purpose exploitation, and we use up the estuaries in the quest for quick use rather than -- as Joe Bodovitz put it so well this morning -- rather than retaining them for future use.

Of course, the thrust of your estuaries and the thrust of our concern this morning is in terms of pollution, but I would remind all of us that pollution comes in many forms. Receiving waters convenient to populations are the convenient place to put massive discharges of domestic and industrial wastes, and in California, especially, because these estuaries are usually close to passes in the mountains. This makes a very convenient and inexpensive place for dumping the highly dangerous agricultural wastes that occur in our great central valleys. Indegradable compounds the sewage effluents from domestic sources and so on can be guided if they are not in excess and if the shallows and other healthy conditions of a living estuary are maintained. They cannot be guided if the shallows are degraded to where the estuary is nothing but a pipeline to the sea. Degradable components cannot be, so here I mean the heavy metals and the waste. These, in my judgment, constitute the most serious immediate threat not only to estuarine health, but to the entire ocean system, and it is high time that we sought ways to fight this problem and its source. You do not solve it by degrading materials into the ocean on the assumption that once you pipe them beyond the door yard of the community, they are out of sight and out of mind.

Other aspects of what might be thought of as pollution, of course, are such things as siltation from mismanagement of our upland areas contributes to pollution of the estuaries.

Single-purpose depletion and destruction by other than pollution, by the cancerous development of the shoreline buildings, shoreline modification so that the amenities of the estuary are degraded and become unattractive, the shantytown condition that we see along so much of our coastline, ugly and dangerous waterfronts and shorelines -- these, too, constitute a threat to the total value of the estuary.

The dredging and filling and other destructive matters constitute a threat. California's concern for estuaries and their health is well known. We have documented some of this already here today, but I would like to just mention a couple of points that may not be stressed unless I bring them up here.

First, in terms of California's particular concern, it is a product of our population and growth as much as anything else. California's leaders are increasingly aware of a need for protecting the priceless values of our some thousands of wave-wash coastline, and some people have estimated about 650 miles of additional shoreline in our estuaries. All of these are irreplaceable assets vunerable to the technological changes that have ever changed any people any place on earth.

Since World War II, this State has doubled in population and has shifted from industry and technology and urbanized centers to become the most populous state in the Nation. Most of its growth has been concentrated along the Coast. Some 13 million Californians now live within an hour's drive of the Pacific, and people tell us that this population should approach 20 million by 1980.

I documented various aspects of this concern in written materials, and I will not repeat them here. I do want to call attention to one other State group which has not been mentioned so far, and these are the two advisory commissions that were created first by the government. Governor Brown appointed the Governor's Advisory Commission on Ocean Resources, and this was reappointed by Governor Reagan, and in 1968 it was given legislative mandate and broadened responsibilities as the California Advisory Commission on Marine and Coastal Resources. This group, recognizing the critical nature of our estuary conditions, the irreversible changes that are taking place, the fact that we are running out of time, has placed a very high priority on the establishment of estuarine reserves.

From the fourth meeting of this group -- and I quote: "The Commission recommended that State Government accord high priority to immediate establishment of reserves in certain bay and estuarine areas that are rapidly being irreversibly modified by man's action."

This was given the highest priority because of the fact the time is running out.

The Commission supported the statement in the Institute of Marine Resources Report that "It is important that a sufficient number and variety of typical marine habitats be set aside as marine reserves to insure the survival of all species of marine plants, invertebrates, fishes, mammals, and waterfowl to preserve the various types of communities. This is necessary in order to maintain large heterogeneous natural gene pools for the future use of mankind; to provide outdoor museums for education and public enjoyment and to supply intellectual and aesthetic appreciation; to make possible scientific research on organisms and communities in their natural state."

The recommendation of this Commission which I think is worth noting is that, and I quote: "Some marine environments should be maintained by the State for low-density use and should be protected from excessive human interference," as I would hope that we never try to equate all values in dollar signs. I hope we will realize that we cannot evaluate values in terms of number of people. There are uses of the environment which call for low-density use.

Two recommendations of the Governor's Advisory Commission which have been implemented by the bodies represented here today include the preparation on a routine basis -- and I am quoting: "Prepare on a routine basis a detailed inventory of all waste discharges (municipal, industrial, and agricultural) to the waters of the State." This goes on to say, "Of especial interest is an inventory of wastes discharged to estuarine and coastal waters."

Another recommendation was, "for assignment of beneficial water uses and establishment of general criteria for the quality of receiving waters for those ocean and estuarine waters located near population centers."

I think it is worth noting here that these recommendations came well ahead of the establishment of some of the Federal policies that have been cited here. They illustrate the fact that while this State has suffered grievously by lack of planning and lack of proper development of its estuaries, there is a growing recognition on the part of our officers and the public generally of our responsibility in this connection.

The final quote of this body I would bring to the attention of this group today is that in November of last year at a meeting held in Sacramento the Committee made a specific recommendation for this program of an environment data collection in California nearshore waters. I will quote:

"In order to augment higher education in the marine sciences, expand field research activities of prime importance to decision-making, and provide meaningful information services to the people of California, the California Advisory Commission on Marine and Coastal Resources recommends that a coordinated program of nearshore environmental data collection and analysis be developed.

"This continuing effort should encompass the total coastline of California. It should be implemented principally by California's educational institutions so that they can provide expanded student opportunities for field research, and at the same time develop the detailed environmental inventories and relative base-line data which are requisite to effective decision-making in the development of California's coastline."

As an educator, you might expect that I am particularly heartened by this recognition of the opportunity for our need for information, our need for data collection and analysis to be coupled with the educational institutions of this State. It is interesting to note in this regard, in 1962, I believe it was, I edited the first directory of marine stations on the Pacific Coast. At that time there were 18. The present issue, some six or seven years later, lists over 50 for the Pacific Coast.

Now, this growth in marine facilities, in marine stations operated by educational institutions represents a growth far in excess of any growth in the educational system as a whole. Rather, it represents a turning of educational and research studies toward the sea and the estuaries. If we are to properly train and man our sources, it must be in the reality of the living source, not from textbooks alone.

Again, as you might expect, a major thrust of my concern today is that we will be sure as we analyze the estuaries and seek ways to protect them that we see this as a part of our responsibility to the future of our training of manpower. I think it is not necessary for me here to say very much about the best uses for estuaries. This has been well covered by the other speakers.

I think the key, the heart, of this concern rests with our establishment of a multi-purpose use for estuarine development. Our recognition of this as a reality, a must mandate, not merely a set of words that we use because they are popular today, but as a frame of reference, that we make our policy decision in deciding which way our estuaries will go.

The State Planning Commission of California used several phrases in a 1965 document which have influenced me a very great deal. They spoke of environmental amenities which have attracted to this coastline the people that have made this a great State, not only the people, but the insurance and commercial developments that have made of this the most populous State in the Nation. Another is that they said that the hallmarks of good planning in natural resource development lies with a concern for retaining the right for future choice or choice to future generations, and this means that we must look to ways in which our estuaries can serve the many functions that they are capable of rather than permitting them to be destroyed or degraded or used up for short-term and nonmulti-purpose use.

I have other notes, but I have run a little overtime. I think I will stop there.

**MR. McCARTY:** Thank you, Dr. Harville.

**MR. ALEXANDER:** I don't believe I have any questions. I want to compliment the Doctor on a very excellent presentation and the fine paper and the time that he has spent in preparation of it.

**DR. HARVILLE:** My pleasure.

**MR. McCARTY:** I, too, would like to add my thanks for your very timely statement. I think it is very pertinent, particularly your comments regarding the values of estuaries and the need for recognizing these values.

**DR. HARVILLE:** I can only add, sir, I think this is one of the responsibilities that we in the educational field have.

**MR. McCARTY:** I would like to call a brief recess here. Those of you who wish to have coffee, I believe there is a cafeteria on the second floor. We will reconvene at eleven o'clock and receive statements for perhaps half an hour to an hour and then recess again for lunch.

(Recess)

...The Hearing was reconvened at 11:00 o'clock a.m. ...

MR. McCARTY: Ladies and gentlemen, we will reconvene the meeting here.

(At which time Mr. McCarty named three individuals and asked if they were in the audience and no response was made.)

MR. McCARTY: Is there anyone in the audience who would like to make a statement for the record here today? If there are no other people wishing to make a statement, we will recess the meeting again and reconvene at two o'clock. I am sorry that you had to wait over the coffee break for this, but we had expected several other speakers later on this morning who apparently did not show up.

So, we will be back at two o'clock. We have several speakers scheduled at two o'clock and again at seven this evening.

(Luncheon Recess.)

...The Hearing was reconvened at 2:00 o'clock p.m. ...

MR. McCARTY: Ladies and gentlemen, our meeting is back in sessions. Before we begin, I would like to read into the record the various local agencies and firms that are represented here today: The City of Newport Beach; the City of San Francisco; Marin Municipal Water District; Solano County Department of Public Health; Alameda Public Works; San Pablo Sanitary District; Santa Clara County Health Department; the Sierra Club; the League of Women Voters; the Pacific Gas and Electric; Standard Oil of California; Phillips Petroleum Company; Crown Zellerbach; Ideal Cement Company, and a number of consulting firms. I won't read all of the names. There are five State agencies and about 14 Federal agencies.

Some of these that I have read will be making statements either this evening or tomorrow morning. In addition, I would like to mention again that in an attempt to bring as many people as possible out for this sort of a meeting, we mailed some 1400 invitations and had hoped for perhaps a greater response, but we know by experience that this sort of thing does happen in public meetings unless you have a very controversial type of issue to bring before the group.

I have one speaker for this afternoon who wishes to make a statement: Mr. Martin Roche of the Regional Office of the U. S. Bureau of Reclamation. Mr. Roche.

MR. MARTIN ROCHE: Thank you, Mr. McCarty, Mr. Alexander. On behalf of our Regional Director, R. J. Pafford, Jr., I would like to express our appreciation for being given the opportunity to present a statement at this public meeting today. As the Department of the Interior's principal action agency for water resources development for over 60 years, the Bureau of Reclamation is vitally concerned with the development and protection of water resources for all beneficial uses. Therefore, we are concerned with the maintenance and enhancement of water quality conditions in estuaries. Of primary concern in our Region 2, which is headquartered in Sacramento, is the San Francisco Bay-Delta Estuary.

Since 1944 the Bureau has operated the Central Valley Project to generally repel sea water intrusion in the Sacramento-San Joaquin Delta. This control has protected 700,000 acres of agricultural lands in the Delta, and has annually maintained the quality of about 4 million acre-feet of water for use in the Delta, in Contra Costa County, and in the San Joaquin Valley.

With the increase in water use in the Central Valley, the quantities of water released into the Suisun Bay portion of the estuary will be changed. The effects of this change on fish and wildlife in the Bay are currently being studied by the Bureau of Reclamation. Present values are substantial, and measures to mitigate or enhance these values are being planned.

The Bureau is presently constructing the San Luis Drain, a 188-mile canal to carry agricultural return flow from the San Luis Service Area in the San Joaquin Valley to be discharged at a point in the estuary near Antioch, California. The continued economic growth of the San Joaquin Valley is dependent on the provision of this needed drainage facility. Many public and private groups have expressed fears as to the possible effects that this return flow might have on the water quality of the Sacramento-San Joaquin Delta, as well as the rest of the Bay Area. The Bureau of Reclamation has taken the lead in initiating two extensive investigations seeking information which will provide a basis for operations which will protect the water quality of this important estuary.

The Delta-San Luis Drain Surveillance program was initiated in 1967 to identify the quality of water conditions in the estuary as they exist today, to determine what effects, if any, the San Luis Drain water might have on the estuary, and to determine what steps should be taken to protect the quality of water in the estuary. The program includes the monthly collection and analysis of samples for physical, chemical and biological characteristics, studies of biological productivity, and studies of biological potential under laboratory conditions. The study, while conducted by the Bureau, draws upon the knowledge, skills and experience of many agencies. Contributing to the program are the U. S. Corps of Engineers, U. S. Bureau of Sport Fisheries and Wildlife, the

Federal Water Pollution Control Administration, the California Department of Water Resources, California Department of Fish and Game, California Department of Public Health, the State Water Resources Control Board, and the San Francisco Bay and Central Valley Regional Water Quality Control Boards.

A primary concern is the possible effect that the nitrogen in the drainage water might have on the estuary. A program was therefore initiated in 1967 to develop an economically feasible method for removing nitrogen from the drainage waters. The Firebaugh Research Program is a joint venture of the Bureau of Reclamation, the Federal Water Pollution Control Administration and the California Department of Water Resources. Present plans are that the three-year program will terminate in 1970, and that the results obtained from this research will provide the basis for developing design criteria to facilitate the removal of nitrogen from the drainage water in the most economical manner.

Summarizing these two studies, the Delta-San Luis Drain Surveillance Program will evaluate the degree of treatment that is needed, and the Firebaugh Research Program will serve to indicate the best method of providing treatment. We are confident that knowledge gained from these two programs will not only enable us to protect the San Francisco Bay-Delta Estuary from detrimental effects of the drain, but will also develop valuable information for the proper water quality management of other estuaries.

For the future preservation, development, and use of estuaries, it may be desirable to allocate a portion of the water supply for water quality control. This may be advantageous on occasions where it is more practical to maintain quality through removal of undesirable pollutants rather than exclusively through waste treatment. Efforts should be directed not only towards studying the problems of estuaries, but should include the development of plans for implementing the improvements needed.

MR. McCARTY: Thank you, Mr. Roche.

Do you have any questions, Bill?

MR. ALEXANDER: In your study, the Firebaugh Research Program, you are studying other things than just the nitrogen removal, aren't you? Are you familiar with that study?

MR. ROCHE: Somewhat. Nitrogen is the main thing that is being studied. The drain water will be from subsurface drains, and the only thing that really concerns us is the nitrogen in the water. The drain water percolation of the soil removes most of the phosphates and pesticides so that these were studied earlier by the State of California, and they pretty well concluded that these would not be a problem.

MR. ALEXANDER: That the pesticides would not be a problem in the drain water?

MR. ROCHE: Right. I think there would be lower concentrations than are found in the Delta now.

MR. ALEXANDER: And only subsurface drain water is going to be permitted in the drain?

MR. ROCHE: We will exclude all other drainage water from the San Luis Drain. We will not allow people along the line to discharge water into the drain which might contain high bacteria count or domestic sewage.

MR. ALEXANDER: Do you have any recent knowledge as to how the nitrogen program is coming along for the removal -- what the present --

MR. ROCHE: Well, when the program was started about two years ago, there were I think eight or ten or a dozen possible solutions, possible ideas to remove nitrogen, and from these, they picked about four that were worth further study that they thought would be economically feasible.

We are working with two presently that show promise. One is the algae stripping where they put the water in a large pond and can promote growth and strip off the algae, and the other is this bacteria process. They run water through a filter or porous media to promote the bacteria to change the nitrogen into gas form.

MR. ALEXANDER: Thank you very much.

MR. McCARTY: Thank you, Mr. Roche.

Do we have anyone else in the audience who wishes to make a statement at this time?

If not, I will briefly go over our plans for the rest of the day and tomorrow so that any of you who wisn to remain for some later speakers can do so, and this will give you some idea on how we plan to conduct the meeting.

We received word that there are three people who would like to speak beginning some time around 3:00 to 3:30. Therefore, we are going to recess the meeting again and reconvene at 3:30 to allow these people to make their statements. We will then recess until seven this evening.

We have on the agenda today now five people who wish to make statements, two from the academic community and three from the Sierra Club.

Tomorrow morning, we have on the program Congressman Waldie and John DeVito from the Contra Costa County Water District.

MR. ALEXANDER: I think, Mr. McCarty, this might give them opportunity for any of them here to prepare a statement in the next hour.

MR. McCARTY: You have a whole hour to put together anything you want to say here. We are particularly interested in getting some of the smaller organizations -- in getting their opinions out here if we can, and if you feel you have the time and would like to make a statement or prepare one, you have between now and at the very latest tomorrow morning at nine o'clock to do so.

MR. ALEXANDER: It seems like we are very well represented by agencies and various forms of government, but we haven't had too many individuals testify.

MR. McCARTY: We would like a few private citizens to give us the real cold hard facts here. Maybe during this evening's session they will be able to get off work and give us some statements.

With that, we will adjourn again until 3:30 and hope for the best.

(Recess)

...The Hearing was reconvened at 3:30 p.m. ...

MR. McCARTY: Ladies and gentlemen, we are again in session. Our first speaker this afternoon at this particular point in time will be Dr. Thomas Harvey from San Jose State College. For those of you who may not know, Dr. Harvey plans to provide us with a slide show here. We have got the room partially darkened for his benefit. Dr. Harvey.

DR. H. THOMAS HARVEY: I see there are not many here today, but just like many groups which you have attended recently, it is not the quantity that counts; it is the quality. So, I am glad to see as many of you here as are because I would like to attempt to give answers to the five interesting questions that are raised here at this hearing.

I represent, I guess, a variety of groups who have endorsed some of what I will have to say -- perhaps not all when they hear what I do have to say -- but certainly I speak specifically in favor of the establishment of a South Bay Wildlife Refuge. This has been endorsed by local Audubon Societies, the Sierra Club's Bay Area Chapter of the Sierra Club and the National Board of Directors of the Sierra Club, and the Save the Bay Association is also in favor of such an establishment, and we are also in the process -- legislation has already been introduced in Congress -- House Bill 2749 is already before them suggesting or recommending to the Secretary of the Interior the establishment of such wildlife refuge. I will come back to that, but I think rather today I would like to introduce this as one of the answers to the collection of questions which have been raised that we might address ourselves to.

So, without further ado, let's see a slide or two.

MR. McCARTY: Dr. Harvey, I would like to point out one thing we mentioned in the beginning you may not be aware of. The proceedings of this meeting are being recorded and will be published in transcript form. It will all be in black and white, and I am wondering whether you would like to have these slides included as a part of the transcript? If you do, they will all come out in black and white.

DR. HARVEY: That is all right with me. Wait until you see the slides, and you can decide whether you want some of them or not. You are welcome to have them to reproduce them if you wish.

MR. McCARTY: Okay, thank you.

DR. HARVEY: We have tried out the slide machine, and you will find it presents some difficulties, but we will go with that. I hope to have a little light over here.

There were five questions asked, and the first one was, "What are the values of estuarine systems such as we have here in San Francisco Bay?" And it certainly is a challenge to try to enumerate these as I see them.

They are of particular interest to those of us who teach ecology or conduct research in such rich and unique habitats.

(Slide)

As you look here at a part of the salt marsh at Palo Alto, which is one of the few remaining expanses of it in the South San Francisco Bay, calculations have been made that close to 80 percent of the salt marshes in San Francisco Bay have already been destroyed, and so those of us who were involved in the teaching of an outdoor science course such as ecology depend on the few fragments which are left. They are of value to us because they possess plants with strange capacities to excrete salt and to withstand internal cellular pressures 20 times that of ordinary land plants. So, they have unique forms of life. What you see here is essentially cordgrass.

(Next Slide)

The next slide shows that there are a few brightly flowered species such as this mum plant which exists at higher grounds.

(Next Slide)

The next slide will show a close-up of this cordgrass with one of the plants capable of the salt excretion, and adjacent to it, pickleweed, and the two of them constitute the major kinds of plants in our salt marshes around San Francisco Bay.

These land plants which have returned to the edge of the sea are apparently among the most productive of all known non-cultivated plants. They seem to be capable of such fantastic yields approaching 10 to 15 tons per acre per year. Most of this food apparently goes into the estuarine waters to serve as the basis and to try to serve as a bottom link in the food chain.

(Next Slide)

If we take a close look at pickleweed, we find there are other things to wonder about it. We find it here entwined with a weed relative known simply as dodder. It is a semi-parasite which serves to raise the question of how one living form may exist dependent upon another.

(Next Slide)

A closer view I think on the next slide emphasizes this very intimate relationship where the yellow vine penetrates the green pickleweed to get some of its food in that manner.

Estuaries are known to be the nurseries for sports fish and other fish which in turn provide recreational values for thousands of people around the Bay Area.

(Next Slide)

Now, somehow this got interspersed at this point as one of the unique scientific values of particularly South San Francisco. They're not quite as awesome of creatures as you might first suspect because most of what you see is shadow above them. That small animal is an endangered species of harvest mouse, simply called the Red-Bellied Harvest Mouse. I realize some people do not care about harvest mice or birds or plants, but some of us do because they are of scientific value as to how it is that they got there, how they are able to maintain themselves and how any endangered species may be on the edge of extinction due to the activities of man, and in this case, in largely the removal of its habitat.

I could add later, but I will add at this point that some have raised the question even though it occurs in great numbers that there is a species that may well be an endangered species, itself, and that, of course, is ours, for as we continue to proliferate and produce pollutants, both in land, water and air, the question is, "Can we continue to tolerate that at the increasing rate of increase?"

(Next Slide)

You see a view that suggests that in estuarine areas, not only is there the water environment, per se, but as it comes in across the mudflats and into the marsh, then it is able to make this exchange, bringing with it nutrients to serve as fertilizer for the marsh plants, in turn, taking food produced by those marsh plants out onto the flats and into the water to be utilized by other organisms. It is from this constant interaction that a web of life is built up with interdepending organisms, as well as habitats.

(Next Slide)

The next slide shows one of the relationships which I think we all appreciate, the simple fact that from a productive habitat there can be recreational sources for human beings, because the fish that these kids are fishing for must ultimately depend on some kind of plant food as the food base.

(Next Slide)

This is simply showing a variety of perch, which can be fished for by children along San Francisco Bay.

(Next Slide)

This striped bass perhaps stands as the one species for sports fishing, as you perhaps are aware. Estimating a value sometimes placed at around $23 million a year spent on sports fishing in San Francisco Bay Area, this one fish accounts for the major portion of that.

(Next Slide)

Hunting has also been placed in monetary values, but I suggest some of the other things, other values -- scientific, educational -- are equally important. It has been placed at a worth of close to $7 million a year, and these are rather healthy economies as far as I can see it, and they, of course, depend on healthy estuaries, a community based on not only water quality, but on healthy marsh plants and phyto-plankton.

I suggest even further that the health of citizens around the Bay may be evaluated on a dollars and cents basis. I do not know that anyone has yet made that calculation, but I suggest that there is value to open space. There is value to those areas which reduce smog increase. There are values in a mental health way for providing recreation of the sort that has just been mentioned.

Thus, I think the establishment of areas for continued natural healthy environments, not only for the organisms that live there, but for us, is of paramount importance.

By leaving the estuary natural, the environment is not loaded with additional pollutants detrimental to healthy lives, and thus we are saved the added expense of compensating for these pollutants.

Although subject to some variation of interpretation, it has been presently estimated that it takes about an acre of shallow water in South San Francisco to oxidize the domestic effluent from 200 homes. If these shallow waters are destroyed, not only is this oxidation of the effluent destroyed but if additional effluents are produced on that acre, we are in a real sense burning the candle at both ends. To destroy the capacity of the estuary means that we must pay to construct sewage treatment facilities to take care of them. We have just recently passed several million dollar bond issues in San Jose-Santa Clara combined for sewage treatment expansion. It doesn't change the treatment. It merely enables the sewage plant to handle more waste and treat it only with secondary treatment, although I hasten to add secondary treatment certainly improves things over what they were a few years ago.

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I was mentioning the pleasure that comes from hunting and recreational activities. There are some who merely enjoy seeing these wild forms, including such diving ducks such as this Golden Eye.

(Next Slide)

It is such an active diver that the next slide shows you the position you usually find it in. That's the rear end of a Golden Eye diving down to get food in the mud.

(Next Slide)

Some merely enjoy the aesthetic qualities that bird watching has provided for them. This is a Snowy Egret which somewhat restores my faith in the bird world because in general, I think of them as not being too bright, but at least this one has sense to stand on a covert and wait for its food to come by.

(Next Slide)

They also serve as a base for learning about the relationship of organisms to their environment, and here almost in textbook style are birds of different lengths of leg and bill positioned along a shoreline in the in-moving tide so that they are not in direct competition with one another. In fact, one is so short-legged and short-billed that it does not even get out in the water, and that is that little gray blob over on the right, which is a kind of Sandpiper.

So, there are lessons to be learned here about the role of adaptation of various structures, of capacity of various forms, of life to maintain themselves in a particular environment.

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It perhaps goes without saying that there are many others who look upon the Bay as a place for recreation in the form of sailing, but I am sure you are aware that much of San Francisco Bay does not allow one to partake of body contact sports because of the level of pollution. Water skiing is not a popular activity in South San Francisco Bay, and I think it could and should be made available. It costs something, though, as I have already indicated, because as we increase the amount of effluent that we dump in, the more it is going to take to clean it up.

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It is not entirely clear what several roles the estuarian waters may play in the abatement of air pollution, but I am inclined to take the word of Dr. Miller who has suggested that it plays a direct role in the fact that if as little as 25 percent of the San Francisco Bay surface were converted from water to land, that at least in San Jose we would get an average temperature change approaching five degrees, and what this does, then, is to change the inversion layer regime so it occurs more frequently in winter, which is another way of saying the lid would be on longer and the smog buildup, thus, greater if that sort of change was triggered off. Possibly a word of caution is all that one can express at this time because the facts are hard to come by, but the knowledge at present and the theories which apply to this knowledge indicate that we should be very cautious about changing our environment in such drastic fashion.

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This gives you some idea of the current water quality in a portion of San Francisco Bay. I will have you just look at it. Perhaps some of you have been there. I often point out that this happens to be the sewer outfall of one of the culturally advanced communities in the Bay. This is at Palo Alto. They speak for themselves.

(Next Slide)

Of course, I would be remiss as a general ecologist if I did not suggest to you where the root of this problem lies, and that is in the unrestricted continuing accelerated growth of the population of California, particularly into the urban areas -- the population explosion, as it is called. Santa Clara County has the distinction of being rated as the fourth fastest growing county in the United States. We grow at a rate of about 40,000 a year. We have some one million in the County already. We destroy from agricultural lands some 10 acres a day, so I wonder where we are headed.

(Next Slide)

I would be also remiss if I did not suggest that there are aesthetic values, but I recognize immediately that beauty is in the eye of the beholder. Most people, I think, can respond to a waving stand of marsh grasses. I like mudflats, but some people do not. To say that one thing is aesthetically valuable to one person is about all that you can say, but I do find many things of great aesthetic value, including mudflats in San Francisco Bay.

(Next Slide)

A bird in flight.

(Next Slide)

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(Next Slide)

Even the duck hunter has some appreciation beyond the sport, I am sure, for the aesthetic qualities that creatures like this exhibit.

(Next Slide)

Here is a species that is not often seen unless you catch them as they are shown here at extremely high tide -- Clapper Rails.

(Next Slide)

Although this is of shell mussels or rib mussels, it moves us on to the question of, "Well, what kind of damage is being done by pollution?

One of the figures which I quote to you is that from Ted Wooster from the California Department of Fish and Game which estimates because of the quarantine on shellfish over most of San Francisco Bay, somewhere near 200,000 man-days per year of recreational clam digging are lost to people around San Francisco Bay.

From Dr. Ganssle's studies at the University of San Francisco, commercial sewage is indicated as reducing the numbers and kinds of invertebrates near their outfalls. Whether this, in turn, serves to reduce other marine forms, of course, is yet to be confirmed.

Again, in 1963, Ganssle suggested that pollution adversely affected salmon migration, which in turn would decrease the subsequent spawning and future populations and thus make inroads into the eventual commercial fisheries.

(Next Slide)

Now, this is just a close view of ribbed mussels.

(Next Slide)

And salmon which I was just referring to.

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(Next Slide)

I will turn now in somewhat closing comments to the final three questions. It was asked rather directly, "What is your answer or your position on the following questions: The future of coastal zones?"

Bluntly, I think that the major emphasis for the future development of our coastal zones should be for public uses, the preservation of large tracts of land in their natural state so that enjoyment and personal, physical and mental health of human beings may be enhanced for the millions of citizens that already live on these coastal regions and visitors from across the Nation.

The question is asked: "What is the best use?"

I recognize that again as a variable with the person's predilections and background, but each of us has as much right to say what is the best use as the next one, and I suggest that the continuing phenomenal population growth of California, especially along the coastal and estuarine areas, makes it imperative to look to the long-range values of these areas. If the suggested values discussed above are valid, then the best use for the greatest number of people is a restriction of commercial development and a development of use areas for the public. The plan developed by the San Francisco Bay Conservation and Development Commission for the San Francisco Bay seems, to me, to closely approximate what I consider the best use of this great estuary.

The question is raised about management systems. I think a regional system should administer the estuarine area of San Francisco Bay and that State and Federal agencies might cooperate on the management of our estuarine resources. For example, the establishment of a U. S. Wildlife Refuge in South San Francisco Bay is presently being proposed. An area of approximately 16,000 acres is suggested by a committee chaired by Mr. Paul McKeehan. One bill, which is House Bill 2749, submitted by eight local Congressmen supports the creation of such a Federal refuge. There are numerous citizens' groups such as Audubon Societies, Associated Sportsmen of California, California Wildlife Federation, Sierra Club and over 240 Bay Area biological scientists who endorse this proposal. Local jurisdictions such as Alameda County, Hayward, and the City of Fremont have also gone on record favoring this kind of use for our estuarine resources.

To summarize it up then, looking at it from the ecological point of view, a major ecologically establishing feature of our coastal zones in California is the estuarine areas. They may serve to enrich our lives by providing a healthy environment not only for the wild plants and animals which abound there if we control our pollution, but, for man himself.

If there are specific questions as to the location and dimensions and reasons behind the Wildlife Refuge proposal, I might answer those. If there are others I am willing to respond.

Thank you.

MR. McCARTY: Mr. Alexander, do you have any questions you would like to ask?

**MR. ALEXANDER:** The question that comes to my mind possibly, Doctor, is to how much area to set aside, and how do we go about procuring or obtaining that amount of land?

**DR. HARVEY:** Well, the reason that 16,000 acres have been proposed is after a study, including representatives from the State Department of Fish and Game and in consultation with representatives from the Fish and Wildlife Service, the 3,000 acres in the three parcels are called simply at present, A, B and C. A is Reiko Island and a few hundred acres on the edge of Bair Island in San Mateo County out to the mudflats and deep water across the Bay which has ecological significance in that with the change in wind, and particularly, ducks and other shore birds can find refuge from that wind by moving across to the lee side. There are about 10,000 acres running from Coyote Slough south to about Mowrey Slough. We haven't drawn specific boundaries because, of course, there will be consultations with local jurisdictions and private landowners in the Fish and Wildlife Service before it is finally serviced.

There are fairly extensive marshes in the Dumbarton area. All of these are considered worth preserving. Then Area C is about 3,000 acres along Coyote Creek or Coyote Slough. This includes such freshwater ponds as well as the marsh and estuarine situation there.

**MR. ALEXANDER:** Are these all in the natural state at the present time?

**DR. HARVEY:** No, it is about half and half between development for salt ponds and in the natural state. The salt ponds serve as resting sites for thousands of ducks in season, and so, are in a sense a near natural situation.

**MR. ALEXANDER:** Is all this land in private ownership at the present time?

**DR. HARVEY:** No. I think there is some question, as you may well know, as to who owns which parts of South San Francisco Bay. I am not clear myself.

**MR. ALEXANDER:** I am wondering if you want to expound a little bit on the management of this as to who should manage this or whether it should be administered by a local group or by the Federal Government.

**DR. HARVEY:** In this case, it being a United States Wildlife Refuge, it would fall to the Federal Government for the management of it. I would assume that they would listen to advisory comments from local groups. I don't know exactly how they run all their refuges. I wanted to ask a question -- what you meant in this announcement as to what system of management -- when I think of wildlife areas, I think of management of them for the variety of species present. I don't know whether you meant management in the political sense as to who --

MR. McCARTY: Yes, this particular point we are most interested in getting expressions and opinions on. The management we are referring to there was primarily of the political nature. We are particularly interested in getting some feedback on what local people think about the relationships of the local interests, State interests, Federal interests in the management of estuaries, not only as wildlife refuges, but as ports, land fill, air systems.

I realize that this program is being sponsored largely by legislation in the Federal Water Pollution Control land. However, we are interested for this particular case in much broader aspects than simply pollution.

DR. HARVEY: Well, then, as I think I briefly suggested in the written material that I have handed to you that a regional agency -- some sort of regional agency would be and I would think should handle it because, again, I am biased from looking at it as an ecologist in that they all are interrelated. The ecosystem here emphasizes San Francisco Bay, the watershed, air-shed, if you want to call it that. The Bay, itself, comes close to being a unit which is most interacting, but there are cases to add, as I think everyone realizes, that the whole surface of the earth is one giant ecosystem which we will have difficulty managing. But, as far as at this point in time, I think at least we can support and stand up and be counted for some regional agency.

MR. McCARTY: So, your general viewpoint would be that perhaps local, State and Federal agencies may be involved in various phases of this?

DR. HARVEY: Right.

MR. McCARTY: You were not here earlier, but one of the things we have been particularly seeking is some expression of the view of various people so that we can convey this to the Congress with the idea that eventually some sort of a national program for the management of the nation's estuaries can be developed. I am certain it will be a combination of Federal, State and local, and again, I am very interested in getting expressions from the public on how this might be accomplished.

Thank you, Dr. Harvey, for a very graphic and illustrative talk.

Our next speaker this afternoon is Dr. Joel Gustafson from San Francisco State College. Dr. Gustafson.

DR. JOEL F. GUSTAFSON: My name is Joel F. Gustafson and my occupation is that of a Professor of Ecology and Systematics at San Francisco State College. I also serve as the Associate Dean, School of Natural Sciences. My statements here today refer to my activities at the College, but I do not officially represent the College. I am also the owner of a consulting business titled "Resources and Ecology Projects".

I would like to present three items to you as exhibits and ask you to consider them for the values they present. The first exhibit that I have in my statement which I am giving to you orally is an action taken by the Pacific Coast Entomological Society in 1967. This Society established a Salt Marsh Habitat Committee of which I am Chairman. The Society has encouraged the submission of notes and observations regarding salt marsh insects and other terrestrial invertebrates to the editor of its journal -- The Pan Pacific Entomologist. The purpose of this action was to develop information which is so sadly lacking.

It is usually the disposition of a conservationist to resort to generalizations and generalities and aesthetic pleas, and the great failure in his pleas is that he lacks substantive fact, particularly local substantive fact to support his statements, his opinions. So, this is an action that I think is encouraging. We took this action and have encouraged some 100 other societies throughout the country to take similar actions trying to build up a fund of organisms that live in the salt marsh community so we will know what roles they play, why they are important, and you bear in mind, of course, as biologists, we are already converted. We know they are important, but we don't know why they are important or how much.

There are two graduate students now doing work in the salt marshes in the Bay Area, one in the Dumbarton part of the Bay Area -- part of the refuge down there. His work to date shows an extraordinary plant life that you find in the salt marsh. The first type which the previous speaker illustrated was cordgrass. Cordgrass has many times the bulk and variety of insects associated with them, with that particular plant. It is the one plant in the salt marsh community which is almost completely utilized by most bacterial composition, and the products go into the foods which are used by a host of burrowing and filtering animals. Unfortunately, most of our salt marsh communities have been reduced by filling from the back end and by diking from the front end, and consequently, cordgrass is the one in the shortest supply and it is the richest one, the most important, if we are concerned with food utilization, annual production of carbohydrate. It is the one that is most sadly lacking.

Most of our marshes are filled with pickleweed, an interesting plant, and it has certain values of loafing grounds, hiding grounds, retreats, but very limited incorporation into other food cycles. Most of the tissue goes into a hard woody stem which does not decay quickly. The roots do not decay, and so when we are concerned with the ecological productivity of the salt marsh, the first plant that I mentioned, cordgrass, is far and away the most important plant, and unfortunately, it now is the least common plant in our salt marsh community.

Mr. Robert Lane is the graduate student at San Francisco State College investigating that marsh.

Mr. Guy Cameron from the University of California at Davis is investigating in a very similar study another marsh over near Petaluma Slough off of the Black Point cut-off highway. The marsh is almost completely different, and here it is a few tens of miles away -- the same plants, but completely different ecology. I want to emphasize the fact that here we have going on two studies at the same time in what is ostensibly the same kind of community with completely different aspects to them.

The thought that first came to my mind was that they were getting experts to identify the organisms and the organisms weren't identified the same way by the experts. Just by chance, nearly all of the specialists who have been very gracious in the donation of their time -- the specialists from the East Coast to the West Coast in most cases are the same people. So, the identifications I think are not only accurate, but they are by the same person in each case whether we were considering one small group of insects or another small group of insects.

The Pacific Coast Entomological Society has developed a very large bibliography of the invertebrate animals associated in the salt marsh. One of the stumbling points for anyone when you get interested in an interesting study is the laborious time-consuming and frequently not very productive literature search you go through. We have done a great deal of this. Duplicate records have been done. An abbreviated bibliography has been published, Volume 44, No. 4, 1968, and we will mimeograph the complete bibliography of salt marsh insects of the world and distribute these also to co-workers. We feel that the availability of the bibliography, itself, will stimulate work in the field.

The second exhibit is one being done for the Bolinas Harbor District of Marin County and the County of Marin, and co-sponsored by the Audubon Canyon Ranch and the Marin Conservation League. It has involved about 14 graduate students, about 20 adults who have contributed many days -- full days of time, some 20 students at the Bolinas-Marin Laboratories of the College of Marin in Marin County, and we are developing the kind of data that ecologists and conservationists really need in order to defend, if you will, the values of a particular area.

If I may call your attention to some particular pages here that summarize the data, Pages 9 to 12 present the data based upon 411 polls taken at 31 different stations throughout the entire Bolinas Lagoon of Marin County. Some 90 organisms have been identified to species by specialists at the California Academy of Sciences in San Francisco, and we are plotting the frequency of these 90 organisms -- the frequency of occurrence at the 31 stations -- and we are now able to draw some tentative conclusions.

These conclusions are ones that any ecologist would assume a priori, but it is nicer to have the data to prove it. We are now able to show natural grouping of different kinds of worms and molluscs, and the natural relationship of mud to sand that is all mud, then muddy sand, then sandy mud, then sand and gravelly sand. You get distinct different kinds of population in these different habitat areas -- these different conditions.

We are able to show the significant role that the amount of plant fragment material plays throughout the Lagoon, and within these different kinds of bottom conditions, and there is also a correlation, as any ecologist would have guessed, between the pollution of the water and the speed of the tidal flow of the water over these shallow flats. Again, exactly what you would expect, but for this particular Lagoon, we now have the data.

This Lagoon will serve as an example of other lagoons in which similar kinds of evidence, I am sure, will also apply, but my intention today is to try to show the addition of information that we are getting which illustrates the typical aesthetic, recreational, wildlife, scientific values, we can actually show the beginnings here of the food cycles involved and why each of these areas is important biologically to the wildlife population, not only of the Lagoon, but to the offshore fisheries as well.

The map on Page 11, gentlemen, shows the Lagoon, and if you will look at that, Stinson Beach is on the right side of this map and directly beneath the end of this lagoon, almost directly beneath it, is a very large drainage channel which drains the bulk of the tidal waters out of this lagoon. It was at the point where this big channel diverged and went in two directions that a year-long study of fish was conducted, three seines made each month, and the species are reported for you on Pages 22 to 28. If you were a fish and game specialist, you might be more impressed with this species list.

Most of the species, 26 species in all, represent a collection of 995 specimens over monthly collections for a full calendar year. We see a live variety of fish, most of which you don't catch. These are rough fish, but they are eaten by the game fish and the food fish offshore. They come into the lagoon, some of them, to spawn, some of them to drop their eggs which wash out and go through larval stages offshore. Many of these are larval fish which use this as a nursery ground and then go on out to be eaten if they haven't been eaten before they go out.

The interesting thing is of the 26 species, we were able to show that 10 of these species had massive populations in the lagoon at, say, a two to a three-month period and then they were gone.

Quickly running down that list at the bottom of Page 24, gentlemen, you will see that the lagoon is important every month of the year. We cannot allow pollution during the summer hoping that it won't disturb things because most things do their spawning in winter, because this is not true.

About a thousand feet to the south at the same time, another student -- I call myself a student, too -- was doing a year-long study of very small larval fish associated with a very large tide flat of many tens of acres, heavily invested with a green algae called sea lettuce. We were wondering whether or not the sea lettuce which looks like big sheets of boiled lettuce would serve as a natural entrapment for larval fish, and indeed it was, and the list is presented there on Page 25.

One of the interesting things is that he got Pacific herring at this station in terms of hundreds, and by that, I mean 300 to 700 in one seine. A thousand feet away approximately, I didn't get one for the entire year. This indicates the value and the distinctness of channels versus flats.

If I had based my interpretation on my data, which I thought was pretty good, I would have missed the Pacific herring which was there in terms of thousands. We could have got them by the ton. It was there as a very tiny fish, and as soon as it got up to pretty good size, it left the lagoon, and you didn't see it again until next year.

That student was Mr. Ken Adams.

At the same time, another student was investigating a very small creek that runs year round dumping into the north end of the lagoon, and I would call your attention to Page 26, and you will see again that we have months of importance. Very briefly, some of the fish were rare, some uncommon, some common in January to May. Another group was common in May to August; another May to December; another January to April. Again, the point that I want to emphasize is that if you add these months together, we are into a full year again.

We investigated also the larger organisms that were in the mudflats and sandy sand flats. A previous reference was made to the number of hundreds of thousands of hours engaged in digging clams. We dug quite a few hundred, too. They were aged, and to our surprise, we found that nearly all of the gaper clams which are a very much sought-after clam and the Washington clam -- nearly all of these clams were between the ages of 10 and 12 years of age. For the Washington clam, out of almost 200 clams, it was -- 144, pardon me -- we had only 10 clams that were less than 8 years of age.

Now, what this means is that for some reason we don't know the age classes and the intervening years have been remarkably unsuccessful, and all the clam digging is being based upon a very successful period some 10 to 12 years ago, and the same thing holds true for the gaper clam.

Now, clam digging is not only good recreation; it is a source of food for many families, and this is a problem now under investigation by two more students. We have no idea -- and we have raised a bunch of guesses so far -- we have no idea why the clams are successful for a few years and then not successful for so many other years. This is the kind of thing I think is important data to know, and unless you get out and look for it, you will never know it.

The clams -- both the gaper and the Washington -- are very sensitive to pollution. They are remarkable concentrators of sewage pollution. They are also remarkable concentrators of copper and zinc and lead. We have a considerable pollution problem in Bolinas Lagoon, and for those of you who eat clams, by all means grind them up and cook them in chowder. Don't make the patties -- not of those clams; they're too rich.

Under the direction of Professor Richard Doutt who is a Director for the Biological Control Laboratories at the University of California, Berkeley, a group of seven members of the Audubon Society and of the Canyon Ranch organization did a series of bird censuses for us. The particular months during which those particular birds are available or present in the lagoon is shown on Pages 29 to 33. An exhaustive study of the research produced only a half dozen references to the food value of these birds, and I am concerned about the lack of data in all of these areas. I am concerned that we are not able to say for most of these birds what they eat and where those organisms are produced and where they occur. This is a significant area of lack of information which we absolutely need if we are to protect those areas by whatever means, but are critically important to the biology of the inland as well as the outer shore waters.

There are quite a bit of other data in there that I won't take the time to give you, gentlemen, but what I am trying to emphasize is that mostly what we lack is data. We have got lots of opinions; we have got lots of emotions, and I have tried to give you some.

The last exhibit is a statement by Professor James P. Mackey, which the secretary has, and I would just summarize in a few sentences. He has conducted for three years a study of the fishes of Corte Madera Creek that runs year round and dumps out in the Bay near San Quentin.

He has over 20 species of fish, including such important ones as striped bass, rainbow, topsmelt, and quite a number of other smelt relatives which are largely eaten by other fish. When you add these all together, they are present also at varying months, including summer.

So, I would emphasize that your attention be drawn toward even little rivulets of fresh water coming into an estuary, that we concern ourselves not only with the presence of a salt marsh, but also with the quality of that salt marsh, the variety and combinations of the plant variety in it. We must concern ourselves with the circulation of water to and from that area. A salt marsh at the back end of a dirty bathtub is still going to be a polluted marsh.

I think I have taken enough time. Thank you. I would be happy to answer any questions you might have.

(Letter dated November 20, 1968 from
Professor Gustafson submitting notice
for publication THE SALT MARSH HABITAT
entered in the record as Exhibit No. 1
to presentation by Professor Gustafson)

(Ecological Study Bolinas Lagoon entered in the record as Exhibit No.2 to presentation by Prof. Gustafson)

(Letter dated February 18, 1969 from Professor James P. Mackey entered in the record as Exhibit No. 3 to presentation by Prof. Gustafson)

MR. McCARTY: Thank you, Dr. Gustafson. A point or two for clarification for the record, perhaps. In your second exhibit, the Ecological Study, could you very briefly give us a picture of what you consider to be the pollution situation in Bolinas Bay? You have touched on the fact that clams -- that we ought to be suspicious of the clams there.

DR. GUSTAFSON: Yes, I had two studies done in different laboratories because I wanted to be sure the data was as bad as it looked, and the most probable number which is an indication of the total gross bacteria pollution from the Stinson Beach drainage, which theoretically is good because it is all septic tanks, was 23,000 individuals per milliliter of water. The little town of Bolinas dumps some of its raw sewage right at the mouth, coming into the lagoon, and that is where I thought the major source was.

They only contributed 6200, and I took it right above the outfall. I knew I was there by the material nearby -- the E.coli -- this is a material that is a complete assurance that what you are dealing with is human sewage and not sewage from birds and cows and so forth, and the figures were extremely high for both the Stinson Beach drainage and the Bolinas areas. They were low in other areas where the tides were covered by birds and bird droppings.

The trouble is if you have E.coli in the water, all you need is a typhoid carrier loose in either drainage, somebody with hepatitis or viral infections of the liver other than hepatitis or dysentery -- this is why I recommended to you gentlemen that you cook the clams thoroughly. It is all right as long as you cook them. From a public health standpoint, I'd sure be worried.

MR. McCARTY: I was primarily after, as I say, the contributing population of the Bolinas Bay area and its drainage area, for example, and information on this.

DR. GUSTAFSON: No, that's coming up in the next report. You mean the sources of pollution besides sewage?

MR. McCARTY: A general idea of where the source of the pollution might be -- where the pollution might be coming from. Obviously, there are people there.

DR. GUSTAFSON: Well, we have also in summer months maybe 600,000 people that come to Stinson Beach State Park.

MR. McCARTY: This is total through the summer?

DR. GUSTAFSON: Through the summer, yes. The populations, themselves, in the two towns are quite small. There is practically no agricultural pollution in terms of pesticides, no oil. We are investigating three drainages for copper. There were some ancient copper mines there, and copper is about the last metallic iron you want in any kind of an aquatic situation. It is very bad.

MR. McCARTY: One last question: In your studies, have you noticed any direct relationships between this pollution and the various organisms that you have studied in terms of numbers and species and this sort of thing?

DR. GUSTAFSON: Do you know Bolinas Lagoon physically? If you look on the map on Page 7, way up toward the left end is the road to Point Reys. The number of organisms, the kinds of organisms there are completely different with just a couple of similarities as the organisms that you find right at the base of the bluff of the town of Stinson Beach, which is extraordinarily rich. It is just sort of a very tag-end, very long, narrow finger-like extension of the lagoon with very poor water circulation.

The life there is only a fraction in terms of bulk and just a few species because it is overrich, and then, as you get away from the richness, you get into areas which are properly fertilized, and this is where you find the great abundance, and these are in areas of a mixture of sand and mud, but they also -- that just may be a coincidence because they are also in areas of better water and circulation and flushing.

MR. McCARTY: Thank you.

Do you have any questions, Mr. Alexander?

MR. ALEXANDER: I think you asked two or three of the questions that I had in mind, but I was wondering primarily about the pollution as to whether this ecological study, whether your properties or whether your plant life and everything, as well as the marine life, would be different if you didn't have any pollution going in there whatsoever? I mean, would you have completely different colonies, so to speak, in there or would it be the same?

DR. GUSTAFSON: No, I am quite confident that the -- I have to answer it this way -- it is a little involved: The organisms that you find in these estuaries and lagoons concentrate materials, concentrate minerals. They concentrate such things as phosphates and nitrates, so what you have is a continuous filtering of this material by flushing water so that there is a natural kind of high fertility of the water if it is shallow. So, we wouldn't need any extra pollution to enrich the water. Biologically, it could enrich itself due to the concentrating organisms that are there, and in these shallow waters, you have tremendous numbers of diatoms and several species of algae, green algae particularly, which are just tremendous producers of food.

Some of these algae leak about 10 percent of their sugar production into the water per day, and some of the worms that sit in the mud can just absorb through their body wall without even feeding about 20 percent of their body physiology needs.

So, it is rich, but it is too rich now, so without the pollution, we would get back those kinds of organisms which are more active participators in being eaten, and then get into the food cycle by the organisms which we might say are more desirable, the fish and the bird, rather than rich stinking mud.

MR. ALEXANDER: Then it would improve the wildlife habitat?

DR. GUSTAFSON: Oh, immeasurably -- very much so.

MR. ALEXANDER: What is the primary pollution then in that particular area at the present time?

DR. GUSTAFSON: The sewage pollution from the two small towns.

MR. ALEXANDER: From the two small towns?

DR. GUSTAFSON: Yes. The difficulty is we are dealing with a small lagoon, some 600 surface acres, with only one small opening, so the tidal flow is delayed as well as restricted. If you envision the lagoon as sort of two "Vs" put together with one V being the opening, the polluted waters go up to the extreme ends, and by the circulation being very low, the debris, the sediment, the silt -- all of these things trap -- by adding to the outside, physically binding to the outside -- they trap the pollution to the soil particles which become part of the sediment. So, you have a natural removal, a scrubbing, a continuous addition of pollution right in the areas which already are physically the poorest because of the circulation pattern, and that's why I found so few organisms there.

It is like having a dog put all of the nitrogen in one spot on your lawn, whereas taking a spreader, you get a nice growth.

MR. McCARTY: Thank you, Dr. Gustafson.

I might say I have been quite impressed with your report on the Ecology of Bolinas Lagoon, and one particular statement caught my eye here. I thought I would mention it to the group before we pass on to the next speaker. It says simply, "Harbor seals snore - loudly!"

DR. GUSTAFSON: I knew that would be quoted.

MR. McCARTY: It is pretty hard to miss that one.

Our next speaker this afternoon is Dr. Gene Willeke, representing Stanford University.

DR. GENE E. WILLEKE: Mr. Alexander, Mr. McCarty: My name is Gene Willeke and I am Acting Professor of Civil Engineering at Stanford University.

I would like to present information this afternoon on the social values of San Franciso Bay and how pollution of Bay water has affected the recreational activities of Bay Area residents.

MR. McCARTY: Excuse me a minute. Do you have a copy of your statement available?

DR. WILLEKE: I don't yet, but I can get one. I would like to do that.

MR. McCARTY: Thank you.

DR. WILLEKE: I would also like to make a few recommendations based on this information collected about the social effects of pollution on recreational activities.

Under a research grant from the Federal Water Pollution Control Administration, I conducted a sample survey in 1967 among adults living in the nine Bay Area counties. This research was done for my doctoral dissertation. To the best of my knowledge, only one other survey of this general type has been conducted, on Lake Onandaga, near Syracuse, New York. My primary intent was to determine what effect Bay pollution had on the recreational activities of Bay Area adults.

I found that Bay pollution does, indeed, affect recreational activities. About 25 percent of Bay Area adults do not use the Bay for recreational activities because they think it is polluted. More precisely, they think the Bay is polluted or dirty or smelly or oily or has floating debris -- something of this type.

On an individual activity basis, the largest effect is on potential swimmers. Twenty percent of the population say they would like to swim in the Bay but do not because they think it is polluted. This is an important finding in view of the fact that there is a prevalent notion that the Bay is too cold for swimmers. It is probably too cold for me, but the fact is that pollution, rather than temperature, is a major factor preventing about 800,000 people from swimming in San Francisco Bay, which would be 20 percent of the Bay Area adults.

Water skiing is the next activity next most affected. Over 5 percent of the population do not water ski on the Bay because they think it is polluted. This is twice as many people as have ever water skied on the Bay and almost as many as the persons who went water skiing anywhere in 1967.

Boating and fishing are much less affected, in the sense that people cease to engage in these activities because of Bay pollution. In each case, only about two percent of the population avoid the Bay because of pollution.

The social effects of Bay pollution go beyond effects on recreational activities. Half of the population, 50 percent, considers Bay pollution the most unappealing aspect of the Bay.

More than one-fourth of the people in the Bay Area are unwilling to eat fish caught in the Bay because of possible ill effects. About one-fourth believe contact with Bay water could be harmful to a person.

The supposed effects of Bay pollution and the supposed condition of Bay water are due to observable effects such as I mentioned before, such as floating material, turbidity, foam, and odor, and especially odor in our part of the Bay -- South Bay -- and to the information that people have picked up from others. Much of this information is not well supported. For example, the foam at the Dumbarton Bridge looks like detergent foam and, if it were, this would indicate poor sewage treatment. It is, rather, salt water foam, and, therefore, we are having an opinion formed on the basis of observation which is in actuality a faulty observation. The people don't know this, and there is really no one to tell them about this at the present time.

The basis for opinions and attitudes leads to some conclusions about Bay pollution control programs. In addition to improving the chemical quality of the water, especially surface material, nutrients and, in some places, dissolved oxygen, there needs to be a solid public information program to tell the facts about the Bay in simple, laymen's language. A brochure with a map that tells and shows where the clean and dirty places are, as well as points of recreational access, would be one approach.

There needs to be a change of attitude about the relative effects of temperature and pollution on Bay swimming.

I would like to suggest also that there needs to be an agency, preferable State or local, with the authority, manpower, equipment, and budget to clean up beaches and water surface on a continuing basis. Much of the material that incites the imagination of persons about pollution does not come from identifiable sources, although certainly some does. But, there is a certain amount of diffuse kind of material that at the present time is really no one's responsibility in the sense that they have a budget, people and the authority to go out and do these kinds of things.

Returning to public information for a moment, I think it is important to note that one of the conclusions of this survey was that about one-third of the people know nothing about Bay pollution or else consider it not polluted at all. This is the margin of a bond issue election that requires a two-thirds majority for approval.

I would like to make just one more point. We in the pollution control field have tended to emphasize bacteria reduction. I think this is very much in order. Shellfish that were mentioned by the preceding speaker would be an example of this, but for recreational uses, there has never been a demonstrated relationship between bacteria counts and harm caused to users. In view of the cost of chlorinating sewage treatment plant effluent, it would seem that bacterial reduction to benefit recreation should be de-emphasized and the money used for other, more urgent waste treatment problems, if there are no other reasons for bacteria reduction.

To summarize, the adverse social effects of Bay pollution are substantial. The most important form of pollution is that which produces observable phenomena that can be seen or smelled. Pollution control efforts should concentrate on these effects, deemphasizing bacteria reduction. In addition, the people need to be told about the Bay, honestly, and in clear, laymen's language. Support for pollution control comes from people. To get it, they must know the facts. They don't appear to know them now.

I would be happy to answer any questions. I will be providing a written summary of this to you.

MR. McCARTY: Thank you. I don't believe you were here this morning, but the deadline for receiving those statements is March 14.

DR. WILLEKE: Thank you.

MR. McCARTY: Did you have any questions, Bill?

MR. ALEXANDER: Yes. When did you make your study?

DR. WILLEKE: This was done in September-October, 1967.

MR. ALEXANDER: In 1967?

DR. WILLEKE: That is correct.

MR. ALEXANDER: You are familiar with the Delta-Bay study?

DR. WILLEKE: I have not seen it. I know it is under way, but I have not seen a copy of the report.

MR. ALEXANDER: We will be holding hearings on it before too long as far as our State Resources Control Board is concerned, and it is nearing completion, and we will send it to the Legislature.

DR. WILLEKE: I have sent a copy of the study to the State.

MR. ALEXANDER: They have copies of your study?

DR. WILLEKE: I have talked with them on the telephone.

MR. ALEXANDER: Very fine. It is a good report.

MR. McCARTY: One further question: Your findings apply primarily to San Francisco Bay -- at least your study applies to San Francisco Bay?

DR. WILLEKE: It applies entirely to San Francisco Bay -- San Francisco, San Pablo.

MR. McCARTY: Would you care to hazard any guesses as to how your conclusions might apply to other estuaries around the country?

DR. WILLEKE: I think that they would be very similar. It is something that would be very easy to check, but I think we would find they would be very similar. Concentrating the attitudes are very much formed by what can be seen and smelled and by the information picked up by other people and not necessarily very reliable sources. The lines of communication between the people who are knowledgeable, recently the Federal, State and local agencies, as a whole, have not been too good for a number of very good and sufficient reasons. This forces many people -- well, perhaps it doesn't force them -- but at any rate, the person who would move into the Bay Area, for example, would pick up this first information from his neighbor, but then this opinion formed about a very small portion of the Bay tends, then, to apply to the whole Bay.

If one drives across Dumbarton Bridge one sees the whole Bay as being the same as that under Dumbarton Bridge until something different is shown. So, I think we would tend to find similarities throughout the country.

MR. McCARTY: I think your study is unique in this respect, the analysis of social values related to water pollution. Do you know of any other studies of this type around the country that have been made that directly relate to the pollution problem?

DR. WILLEKE: Only the one at Syracuse, New York, on Onandaga Lake, which was reported in the October issue of Water Resources Research. It was not as extensive as this, and, of course, does not involve estuaries. It is on salt water lakes.

Another survey of this type has been considered for Appalachia, but I don't believe it is under way yet, and maybe it has not been funded.

It is a rather inexpensive way to acquire this kind of information, though, and with the groundwork we have here on questionnaire development, this could be supplied at fairly low cost, and the information could be acquired very rapidly. A year or two would suffice for much of the country.

MR. McCARTY: Was it low cost through the approach you used?

DR. WILLEKE: Yes, even if we take that component out, the large component of the cost is the survey, itself, and that is substantially constant wherever you would do the survey. The only additional parts are things like salaries which, for graduate students, are very low. Nevertheless, much of the work has been done in deciding what kind of analyses are required in new future studies. That effort would be less expensive.

MR. ALEXANDER: What was your sampling program?

DR. WILLEKE: The sampling program here was the random type cross section sample of households in the nine Bay Area Counties It was done by a field research corporation here in San Francisco who did do the California poll, and the techniques of sampling were identical to those used for the California poll. The key address was selected from the telephone directory and additional interviews were conducted based on that key address.

MR. McCARTY: Thank you, Dr. Willeke.

Do we have anyone else in the audience wishing to make a statement at this time?

If not, the meeting will be recessed until seven o'clock this evening.

(Recess)

...The Hearing was reconvened at 7:20 p.m. ...

MR. McCARTY: Gentlemen, I believe we are ready to reconvene our meeting this evening. I recognize quite a few faces from earlier in the day. However, I might just make a few brief remarks for those who were not here earlier to indicate our procedures.

Very briefly, we are transcribing this -- these statements. They will be a part of the record, and we would appreciate any illustrations that you may have or any slides you may have. Be sure to remember that in the transcript these will appear in black and white, so if you are trying to point out certain things or you are making statements such as "over there" or "this point in red," try to remember that it will be a part of the transcript, and make your statements such that they will be intelligible read from the transcript.

I should also point out that we are here to receive statements and receive ideas and receive views and thoughts of interest to the people, private citizens, conservation groups and the like, on matters related to the nation's estuaries. We would like to receive all viewpoints that we can possibly receive. We do not intend to make this meeting a debating place or a forum for debate. We are primarily interested in receiving your views, your thoughts, so we can collate these thoughts and transmit them to the United States Congress for their consideration in developing a national program for the control and management of our nation's estuaries.

One additional statement I should like to make, for those of you who feel you do not have time to prepare a statement but would like to have something in the record, you have until March 14 to submit a statement to us in writing. We would be more than happy to include it in the transcript. If any of you would like to proceed in that manner, you can contact Mr. Irving Terzich who is in the rear of the room at the registration table, and he will be happy to supply you with the necessary information to get your statement into the record.

With that brief introduction, we will call on our next speaker for this evening, Dr. Howard L. Cogswell from the California State College in Hayward. Dr. Cogswell.

**DR. HOWARD L. COGSWELL:** Since I did not know what the time schedule was -- I did not receive the official announcement, although I had been contacted last week -- I did not receive the official announcement until today. I am somewhat unprepared.

I am, first, Associate Professor of Science at California State College, Hayward. I work primarily in ornithology and ecology. I have been doing research on and off, but intensively the last four or five years on the bird populations of San Francisco Bay shores, particularly as related to the tide flat regions, and I will try not to overlap what perhaps has been covered here already--the salt marshes, the Bay as a whole, and things of this sort--but with regard to the tide flat area, particularly in the South Bay, South Oakland, San Francisco Bay Bridge.

At two different times, I have attempted to come up with some quantitative figures, which, in searching the scientific literature, I find lacking with regard to the bird populations that a given acreage of tide flat will support.

As almost every bird watcher who goes out with an alert mind will tell you, the tide flats are the prime food support for the large numbers of birds that are found there. This does not apply to all birds in the Bay, but it does apply to the large group known as shore groups of which there are 15 to 20 species frequenting the Bay, some of them in numbers up to a quarter million or more in the South Bay at the migration periods.

It also applies to a large number of diving ducks which are probably the ones which have been covered in your hearings by those engaged in studies of game bird. The diving ducks are also supported by the shallow waters below the tide level, but still below six feet in depth.

I want to present material here just on the populations of the tide flat area because this seems to be ecologically the largest gap in the knowledge.

Fish and game, for example, researchers operating aboard a boat with a power dredge and a winch to haul it up can't get into the tide flat. So, it's never been studied from that regard. So, it takes somebody on shore going out in a flat-bottom boat or somebody on shore to do the sampling. We are just really getting under way for quantitative samples other than for the bird samples alone.

First, midwinter populations are medium in the Bay, and yet, it is in the midwinter that I have happened to have the time in four or five years in order to engage in census work, and on the south shore of Alameda and San Leandro Bay back in 1962-63 when there was more mudflat there than there is now, we came up with a total population figure for shorebirds alone of 15 to 20 species of birds, including feeders. We came up with a figure that averaged 18 birds of that group per acre of tide flat. This was in the late December early January period.

They did this by counting the birds at their high tide waiting grounds. Using a different method since I went to California State College at Hayward in 1964, we have been concentrating on a particular measured survey, 100-acre patch of tide flat, which we chose there north of the San Mateo Bridge and chose because it was accessible to us and chose it as we looked at its average. That is, it was neither maximum in bird population nor was it minimum, and it was readily accessible.

The tide flat is about 2500 feet wide at the zero tide line, and in five winters of censusing, chiefly in January and early February repeatedly over that hundred acre plot which we are able to do comfortably from a dike with a telescope, we have come up with a figure of 14 to 16 1/2 or 17 birds per acre, which, if you measure it at the time the tide flat is exposed, that number of shorebirds, averaging in the diving ducks and so on that come in at the high tide, you get a much higher figure or lower figure depending on how you average the time-related base.

These shorebirds -- roughly 16 shorebirds per acre -- are being supported food-wise upon that area. The important feature is that this is the food source, and this is an additional reason, I feel, for supporting conservation measures which would maintain that intertidal region with its acreage that alone is not sufficient to support this population of birds.

Adjacent areas for waiting out the high tide period are highly critical because none of them can stay in the water during the high tide period. Shorebirds have to go somewhere on land, and it has to be within easy flying range. Salt marshes originally did.

Why do I stress the shorebirds? Because they are considered non-game. They used to be game birds, but they cannot support intensive hunting pressure. I support them because they are interesting. There is a variety of species. It is a real spectacular sight to be out there on the shore of the Bay and see flocks of 80,000 birds pass over at the peak of the migration season. You can do that at some of the better spots.

Direct economic effects upon man -- I have no comment about them. I do not see there is a dollar and cent value I can place on it except from the viewpoint of education for better understanding of a complex environment with an interchange of land and marine resources being used. The educational value I think is immense.

To relate this to the prime topic of your hearing, that of pollution, I said that this area we were studying at Hayward was not the peak population. The peak population of shorebirds along that seven-mile stretch I have had access to there, on and off, is at the Oraloma sewage outlet. Now, they are rebuilding the plant under instructions from the Water Quality Control Board.

The number of feeding shorebirds within that plant outnumbers those further down the Bay where I have censused. Now, it is true that other sewage outlets had almost no shorebirds because there was not but anaerobic bacteria there.

Something in between the pollution level which kills all life in the Bay and the nice, clean, white, sandy beach which again has no shorebirds because there is not much there to eat is the pickleweed life population for both this group and some of the diving ducks. The famed Canvasback feeds right in the same area.

I believe that is about what I wanted to say, sir.

MR. ALEXANDER: You need some enrichment then?

DR. COGSWELL: You need some organic enrichment. Unless we find some other way to dispose of our wastes, I see certain areas of the Bay maybe that wildlife education could be the use and still maintain the disposal aspect. Currently, if I may take a moment more, I am on a research aspect, but it is another whole aspect of pollution. I am studying solid waste disposal and bird hazard to aircraft. I guess this is a form of air pollution. I don't know.

Thank you.

MR. McCARTY: Thank you, Dr. Cogswell.

I would like to call our next speaker who represents the San Francisco Bay Chapter of the Sierra Club, Mr. Edwin B. Royce.

MR. EDWIN B. ROYCE: May I first thank you for the opportunity to present material here. The San Francisco Bay Chapter of the Sierra Club has for some time now been interested in water quality problems. It has had an active subcommittee on water quality problems. The chairman of that is Peter Zars who will talk a little bit later tonight. We certainly appreciate the opportunity to talk on this subject and also the interest in water quality and estuarine systems which is represented by the fact that we are having this hearing at all.

I would like to talk in particular about a study that the Chapter's Water Quality Subcommittee undertook last year. It started I guess about a year ago and led to a preliminary report in June or July. This is a study that we did on water quality in the San Francisco Bay and the Sacramento-San Joaquin Delta system. We did this or we started out essentially as a matter of self-education. We wanted to find out what the problems were in this area and then it identifies some of the problems. Perhaps we have some idea of what sorts of solutions we ought to advocate.

As we got into the Bay Delta problem, of course, we came across a lot of the problems which have been recognized by many others who have already studied that system, and let me just run through a few of the things it would seem to us to be critical problems. I will try to do this fairly quickly since this kind of material, at least in some aspects, has been reported by others.

The one thing that is unique about our study, I think, is that we attempted to provide an integration of all the sources of information we could get -- reports from various agencies, State and Federal, tried to get an overall picture of what the water quality problem was. We found most of the reports we got our hands on almost invariably concentrated on one particular aspect of the problem. It did not seem to address the general questions as much as we would like to.

What we found out, of course, is that it is probably fairly well known that the pollution problem, particularly in the Delta system, is a result of two kinds of things that are happening: One is the fact that as our population grows in that area, industrialization grows. There is increased agricultural development in that area. We are seeing an increased inflow of wastes of all kinds into the waters of the Delta and at the same time, this is being combined gradually with a reduced outflow of water to flush this solution out of the area. So, it is combination of these two things, and they have to be looked at together, and the solutions, then, obviously require attacking both sides of this problem; namely, maintaining flows to flush pollution out of the Delta area, and this is important not only for the Delta but for San Francisco, particularly winter flushing flows which seem to be fairly important in clearing wastes out of the Suisun area and San Pablo area. So, we think it is important to maintain these flows.

At the same time, we have got to take a look at this problem of increased input of wastes. Now, the wastes come from many forms or from many sources. There are, of course, municipal, industrial wastes. Those are sort of straightforward-to-treat ones. You realize you have got them there. Clearly, more work has to be done along those lines to reduce the inflow of wastes if we are even going to try to maintain the present water quality that we have.

There is also the problem of agricultural waste waters coming into the Delta. We at first were worried about the drains. That is one of the things we thought we ought to find out a little bit about when we started the study, and we decided that was a thing that needed to be worried about. The problem of nitrates in the drain waters, of course, has been well discussed. For that reason alone, it seemed to us essential that the drain should not discharge into the Delta.

Since that time, we have heard a great deal about the developments that have come along in the treatment of nitrates in drain waters. We still think that there is a substantial amount of nitrates left.

We are also worried about what we call exotic chemicals, and we include by that the pesticides, as well as other chemicals, toxic salts, toxic materials that might come through these drain waters, and we were worried particularly in terms of the preservation of the fish in these waters. Of course, it has been stated that the waters that are going to come out of the drains are going to come out of tile drains, and they are very low in pesticides. If that is indeed true, perhaps there is not a problem. We are not convinced -- it did not seem convincing to us that was the case, and we are still worried about this, and we feel a lot more attention should be given to this.

We are also worried about the dissolved solids in the drain waters. This is something you cannot do a great deal about. The studies have again indicated that with reduced flows in the Delta that the level of dissolved solids would be such that the drain would not provide any serious problem. We believe the flow should be maintained at considerably higher levels. I will come back to that in a minute.

There are the dissolved solids that would be coming through the drain waters that would, in fact, be detrimental to the Delta waters. For these reasons, we think it would be better if these drains did not go into the Delta.

I have talked about some of the sources of the pollution and the results of the flows. There is also the question of salinity intrusion into the Delta -- the fact that flows have to be retained in order to prevent that. A lot of people have discussed the problem of salinity in terms of the agricultural developments in the Delta and the industrial uses of waters. Our primary interest is in terms of the preservation of the fisheries in the Delta, and some of these studies that we have seen that are coming from the

Department of Fish and Game seem to indicate, at least the way I read them, that a major salinity intrusion would have quite disastrous effects on the, for example, striped bass -- not so much on striped bass, but on the shrimp that the bass feed on.

You might think that the whole population would move upstream as you had salinity intrusion and there would be no problem. The fact is that the channels upstream are very different from the downstream area which the shrimp live in which is in the western part of the Delta. This is not necessarily a good habitat for them.

I don't know whether Dr. Tarp is here yet, but I think he probably has some data that will illustrate this fact a little bit more graphically because he has data that shows the direct correlation between salinity intrusion and the population of striped bass in the Delta.

These are rather specific things that I have discussed, and in terms of more general recommendations, we came up with a few things we thought were important goals that we ought to strive for. We feel that water is released -- the whole release of water into the Delta ought to be managed in such a way as to not only preserve, but enhance, the population of desirable aquatic life in the Delta. This we think is a very important goal.

Further, we think that this management of the water quality in the Delta should be such as to preserve a water safe and attractive for water recreation, water contact sports -- this kind of thing.

We think that flows, thermal gradients, perhaps associated with thermal discharges should not be modified in such a way that they would adversely affect the biological system in the Delta, and we think there should be protection against salinity intrusion in order to maintain an adequate shore line ecology. These are the things we thought were fairly important.

Let me turn now from the discussion of the Delta and talk about the Bay. We can't, of course, divorce these two systems. They are all part of the same estuarine system. Our study concentrated on problems in the Delta to some extent. We found those to be the more challenging problems. We recognize they are very serious problems in the Bay as well.

Based on earlier positions that we have taken in the Chapter, based on our reviews of some of the discussions that have been going on in the BCDC, and just listening this morning and this afternoon to some of the testimony, I jotted down a few ideas that, as I say, are consistent with the policies the Chapter has taken.

It seemed to me to be a summary of what we are striving for in water quality in the Bay.

What we are trying to do to use a phrase is "Save the Bay." It seems to me there are three important things at least that we in the Sierra Club are worried about; namely, preservation of the Bay as such, preservation of the habitat for birds, fish, shore line ecosystems, if you like, and recreational use.

As far as preservation of the Bay, itself, is concerned, I think the best thing I can do -- I would like to quote a few sentences out of the BCDC report because it describes why we want to preserve the Bay as such. The quote is as follows:

> "San Francisco Bay is an irreplaceable gift to nature that man can either abuse and ultimately destroy or improve and protect for future generations. It should be regarded as the most valuable natural asset of the entire Bay Region. The appearance of the Bay and man's enjoyment of it as a scenic resource is valuable to the Bay Area. The wide surface of the Bay offers relief from the crowded often chaotic urbanized scene and helps to create a sense of psychological well-being."

I cannot think of a better way of describing what we mean when we talk about the aesthetic reasons for the preservation of the Bay. I think these same arguments also go really to the preservation of any natural area, particularly where it is immediately adjacent to an urban development, so it does provide this relief between the urban and the natural development.

You have heard lots of testimony already today about preservation of habitats for fish, the necessity of preserving the salt marshes, the mudflats, the importance of these areas and oxygenating the waters of the Bay and providing nutrients that in turn feed the fish and so on, but these are certainly important, and finally, recreational, because, again, really our interest has to be centered on people. We are not talking about preservation of, for example, wildlife habitats just to preserve a habitat. It is because people enjoy seeing birds. They enjoy catching fish.

So, really it comes back to people. This is the whole reason why we really need to preserve these systems. It is centered on people, not on the objects in some inanimate sense or some inhuman sort of sense, and again, recreation is important. This is why we think it is important to maintain the habitat for fish and wildlife and also, again, why we want to preserve the natural scene so that people can enjoy this. It is centered on people.

This is our real interest, and this seems to me the real reason to worry about water quality and preservation and water areas that we have.

I have rambled too far. Thank you.

MR. ALEXANDER: What is your present assessment as to the conditions in the Bay, so to speak? That was the last subject you discussed.

MR. ROYCE: Yes, the information that we have seen indicates that it is quite variable. It depends on what part of the Bay you are talking about. Certainly, in the Central Bay-San Pablo Bay Area, we have quite good water. On the other hand, in South Bay, at least at certain times of the year, there are waste discharges that produce significant oxygen pollution, for example. These are probably the two extremes.

There are, of course, the continual problems of waste discharges from the communities all around the Bay, and I think perhaps one of the speakers is going to talk about that in a little more detail tonight. So, it is variable. We have very good water quality in some areas and rather bad water quality in some areas at some times.

MR. ALEXANDER: When you talk about preserving the Bay, you mean some enhancement from what it is at the present or do you mean in its present state?

MR. ROYCE: I mean a whole collection of things. In terms of water quality specifically, you talk about preservation where we have high water quality, enhancement where there is presently a degradation of that water quality due to discharge of various wastes. That enhancement should be a goal, not merely standing still and holding what we have.

I was also -- when I talked about saving the Bay, which is a common phrase that people use, we are also talking about the whole idea of planning the development of the adjacent Bay lands, whether or not these lands are going to be filled. Preservation of the flats -- again, also perhaps in enhancement. For example, the BCDC report suggests that if the salt flats should at some future time not be productive, perhaps these could be purchased and dikes placed so that this land could go back to the Bay. So, this would be an enhancement rather than just preservation.

Preservation is important, but when we have the opportunity, we ought to try to do more. I may have talked around your question--

MR. ALEXANDER: No, I think you have answered to a certain extent, but then I come to the point, where do the funds come from to get this enhancement and produce the enhancement?

MR. ROYCE: This is the critical problem, of course, and I think that to some extent they have to come from public funds because we are talking about -- by the way, I am speaking for myself now -- we don't have any policy as far as the Chapter is concerned -- but it seems to me that we do have to spend some public funds because this is a concern of the public. People are interested to hear, for example, this report of Gene Willeke this afternoon about public concern for water pollution. You can weigh that one way or another, but certainly that report indicates that there is a concern in a sizable segment of the public. It affects their recreational activities.

I think some of this can come from public funds. I think in terms of pollution -- I think we have to recognize that there should not be a right to pollute in the sense that because we have been dumping this stuff there in the past that we can do it forever and ever and ever. I think that the public does have a right to clean water and waste dischargers do not have the right to pollute that water forever and that some of that improvement is going to have to come from private funds, whatever the people are who are discharging. That may be public funds if it is a municipality or something.

I think in terms of direct pollution, there should not be the right to pollute and, therefore, in cleaning up water quality ultimately, this has to go back to the discharger.

Now, there is the problem of maintaining flows, for example. If you are going to maintain additional flows, for example, in the Delta, where is that water going to come from?

MR. ALEXANDER: You are talking about, say, enhancement of water in the Delta?

MR. ROYCE: I may be talking about enhancement or I may be simply talking about maintaining our present flows in the face of increased diversions. It may be in that case even a holding operation is going to require additional sources for the water to be allocated for water quality.

It seems to me that perhaps this should be charged to the public in some way because it is a public benefit. For example, I have seen a figure that said there are three and a half million recreational days a year in the Delta. I think you count a fisherman who comes out and wants to fish -- that's one unit. I do not really know how you make those people pay for water quality.

Again, this is speaking for myself -- this is not an official statement: I have often thought that in terms of the fishermen, you can do the same thing we do with trout stamps. If you are going to fish in the Delta, you have to pay an extra buck for the fish license -- just as, for example, we do not ask the users of a park to pay every time they go into a public park. It is a public facility that has been paid for by public funds. I think this should be the same kind of thing.

MR. ALEXANDER: It is a tremendous problem, and you have done an excellent job in presenting your picture. I appreciate that, and I also appreciate the testimony that the Sierra Club has given at other hearings and the work you have done on the study project.

MR. McCARTY: One or two points of clarification while you are here. Your statements reflect the policy of the San Francisco Chapter; is that correct?

MR. ROYCE: That is correct.

MR. McCARTY: What geographical area is that?

MR. ROYCE: The San Francisco Bay Chapter includes the counties of San Francisco, Marin, Alameda and Contra Costa. We get into the Delta area because of our Contra Costa representation.

MR. McCARTY: And do you know if the parent organization is considering an adoption of policies of this type?

MR. ROYCE: I can tell you the following: There is at the present time a study group working under the Northern California Regional Conservation Committee which is a coordinating group on this problem. It is a joint committee and includes members of the Bay Chapter.

The Redwood Chapter, which includes Napa and Solano and the Mother Lode, which includes the Delta area -- that group has had a couple of meetings.

Pete Zars and myself are both members of that group. It is preparing a report which in general is following the lines that have been laid down by our Bay Chapter report. But, of course, we cannot say that that is what the final report will be, but those are the lines it is taking at the present time. Once that work has been done, that will then go back to the Northern California Regional Committee for consideration, and from that Committee, it will go to the Board of Directors for the National Club.

That's the state we are involved in at the present time.

MR. McCARTY: One final question: As you may have noticed this morning, one of the questions we have been pushing quite hard is the question of how to best manage the nation's estuaries. What is the general relationship between local, State and Federal interests? Do you, as an individual or as a conservationist speaking for the Sierra Club have any views on this matter?

MR. ROYCE: Well, it is clear that many agencies are involved by the nature of the problems, and that has to be the case. Therefore, it has to be cooperative. That's a conclusion you cannot escape due to the fact there are both State and Federal agencies involved, and they come at the problem with different responsibilities, and those responsibilities cannot be divorced from those particular agencies. So, there has to be a cooperative arrangement.

In terms of the Bay Area, the Chapter has taken the position to support a limited Bay Area Regional Government as outlined in the BCDC report. This was the stand that was taken before the final BCDC came out. The recommendation was one that is similar.

MR. McCARTY: Excuse me, this was a Chapter that took this position?

MR. ROYCE: The Chapter took this position, correct. The Club has made the question of saving the Bay a national policy. It did that at its last meeting. It did not, however, go into specifics at that time, but we'll certainly be getting into that. I'm afraid you will be hearing more from us.

MR. McCARTY: Thank you very much, Mr. Royce.

I would like to now call on Peter H. Zars, who is also a member of the San Francisco Chapter of the Sierra Club.

MR. PETER H. ZARS: As Mr. Royce has explained, we have been doing an intensive amount of study, and since we are not adequately funded for anything of this kind -- you understand, this is all volunteer work. But, I would like to see the Federal Government especially and State and local governments do more work on the questions that you have listed here. We have our own ideas, but the funding is hardly the problem of getting to the bottom of it.

We have realized that the aesthetic values which we are striving for are very difficult to put values on, and we realize that we are in competition with other values, especially dollar values. We have thought about how to put a value on aesthetics, and we have come up with a suggestion, an approach that we are starting to work on now. I speak both for the Bay-Delta Water

Quality Committee and the Technical Subcommittee for the Regional Sierra Club Chapters.

The problem I think can be attacked -- that is, the problem of putting a dollar value on aesthetics -- can be attacked by correlating it to the amount of money that people are willing to pay for the tools that it will take them to get out into the outdoors. Now, the value of a tool does not necessarily mean the value of the end product. It is a tool. So, if they spend thousands and millions and billions of dollars on outdoor recreation equipment such as sailboats or motorboats or water skis or fishing rods or hip boots or whatever have you, you can get an idea of the value that they are placing on the outdoor experience because these are the tools. These are the only tools.

You can take like, for instance, if you wanted to establish the value of the Bay and Delta to fish or to motorboating or to sailboating, you could do as we have started to to find out the relative registrations of boats over 20 feet in this area and see that the registrations are rising at an 8 percent a year increase where the population is going up at the rate of 5 percent. The 8 percent increase doubles itself; that is, if it is compounded as it is in this case, it doubles itself at about twice the rate of the 5 percent increase. This is just the percentages compounded, so that if the registrations are increasing at 8 percent per year, you can have an idea of the value that is being put to this outdoor type of experience and the values that are going into it in order to give people the tools to use this thing that we are talking about -- the aesthetic enjoyment.

You can take the other side of it -- you can take the cost and also consider that; the cost of not having it available. I think as our cities become more and more crowded and as the people are becoming more and more impacted in them and are, let's say, becoming more inhuman, you will find that the costs of this are immeasurable in terms of all kinds of antisocial behavior or in terms of mental illness or what have you. These costs, I think, should also be considered in evaluating an area such as this estuary which we are speaking about here locally.

The big hazard at this time is the pollution problem. It is the biggest single item that is affecting our Bay-Delta system. As Mr. Royce pointed out, the pollution isn't necessarily due to the fact that we are going to dump in twice as much. It is also the fact that we are going to reduce the water volumes that are used to dilute it because we are working on pollution solutions as the solution to pollution. If we are going to subtract half the water, you will be doubling the pollution. There is your hazard.

I think there are two ways of looking at the costs of pollution and the effect on the environment. I think our approach will be that it is best to clean it up as soon as it takes place or, in other words, treat it at the source. Take the example of the litter bag. It is much easier through a public education program to convince people to carry a litter bag than it is to send somebody out with a stick with a nail at the end of it and have it retrieved as it is diluted into the countryside. The same maintenance is true for all other forms of pollution. It is much easier to treat them at the source than it is to minimize the effects.

Another factor in here is that pollution or degradation of any kind attracts pollution. You only have to look at the ends of our roads or at the ends of the city streets and you find that because there is a beer can there, there will be other beer cans tomorrow. So, the idea of cleaning it up as soon as it takes place has been found to be an efficient way of treating pollution.

Those two ways of treating it -- of attacking the problem of pollution -- are by far the most economical. This, of course, takes into consideration the fact that we are dealing with the public and that they have to be educated to this, and I think in this regard, the Sierra Club or at least our activities are going to be channeled in that direction. We had a little TV show on a Sacramento station in an attempt to point this up. We have had some very good responses from it. I think if we continue to point out the dangers and how anyone can participate in cleaning them up or in mitigating them, I think the public participation is vital. We feel it is implicit on the government, the various units having jurisdiction over the Bay and Delta system -- that it is implicit on them to also act on the public behalf and that they should cooperate in the control and the management of the estuary.

We are watching here more or less the death of a great natural asset, a great recreational resource, and it is somewhat like the tragedy of the Commons, where gradually attrition isn't noticed by anyone, but the cumulative effect is enormous.

We would like to try to save the Bay and the Delta. We would like to maybe enhance and improve it. In looking over the entire picture in our study, we have more or less come to the conclusion that there is no reason on earth why this area could not be made into an absolute paradise. We know enough about the management of dams, flood control projects to mitigate the effects of nature which have been drastic in the past or even salt intrusion which has been drastic in the past. We can protect our natural assets, we can protect our ecosystem, our environment, by the proper management. I think we can improve on it, and, as I say again, there is no reason at all in our estimation why the ecology cannot be considered in these studies; why there cannot be a crash program to try to save the Bay and the Delta now.

MR. McCARTY: Thank you, Mr. Zars, for a very thoughtful statement.

MR. ALEXANDER: I am very much interested in the method of developing this thing as to the tools that would be used. That is an approach I have not heard before, and I think it certainly has merit. That is one way of getting at this, but, getting down to the Bay and Delta or the estuary, who would you think should manage it?

MR. ZARS: Well, as I said earlier, I think it should be in relation to the jurisdiction. If the Federal Government has jurisdiction over the ships that dock at the Naval Shipyard in Alameda and can prevent their 4,000-man crew from polluting the Bay, they should, and I think as far as the ownership of the Bay is concerned, I think wherever the State-owned lands are in question or where Federal-owned lands are in question, I think they should be managed in that relation. But, in the overall picture, I think my personal hope would be that if it is proven that the local, the municipalities and then the State cannot take care of the situation, I think our last hope will be that the Federal Government can come in and finally put down the lid and say, "well, this is enough; from here on we are going to enhance the thing and clean it up."

I think that is probably the stand that the Federal Government has taken in the East, and whatever it is called -- coercion or education -- I think we need it.

MR. ALEXANDER: Do you think we are going to do that as far as the population is concerned, too?

MR. ZARS: I hope that we can educate the people well enough, and I am sure that once the comparative values are known and once we can say or once we can reasonably put a price on this, we will realize it does not take much to save something that is extremely valuable.

MR. McCARTY: One last question, Mr. Zars: Your proposal about developing dollar values for aesthetics based on tools and recreation -- do you know of any places where this approach is being applied to any extent trying to get the values for this?

MR. ZARS: Well, there are all kinds of evaluations. For instance, the cost of or the expenditures in a certain area where the weekenders come in and you take the total cash receipts from that period. That is one way. It does not take into consideration the tools.

There are other visitor days or visitor hours or increment hours of 12 hours or 10 hours -- whatever they are -- that the Federal-State Fish and Game and other agencies have tried to evaluate. We find those lacking in the real dollar and cents values. I think we will have to use some of that, but the tool idea is what we are working on right now.

MR. ALEXANDER: It will be interesting to see what you come up with.

MR. ZARS: We may come up with a terrific value.

MR. McCARTY: Thank you, Mr. Zars.

I would like to call on our next speaker, Dr. Fred Tarp who will be speaking as a private citizen.

I know you have charts. Probably I ought to make one statement we have made earlier to speakers with materials to present. This will all be part of a transcript that will be prepared in black and white, so anything you have in color, try to speak so it will be intelligible in the record. Would you like some way to display them?

DR. FRED H. TARP: I will just simply hold them up. I would like to speak as a private citizen tonight although I have done, as you know, work on the Delta in a consultant capacity.

The basic problem that I feel that is facing the Bay at this particular time in history is, of course, the wastes which are coming into the area via industrial waste waters which, of course, are coming in, via nutrients which, of course, come in from the sewage, which you know as well as I do. The region of the estuary also suffers from this particular problem. I think, in addition, that the Delta at this particular time may not suffer some of these problems totally, but as time progresses and as future populations build up with agricultural waste waters, with industrial waste waters, with municipal waste waters, with increased population, this, too, will become a hazard.

I feel that it is possible by a system of waste water management -- just as the previous speaker stated -- that it is possible to stop this at its source, and I think this is, of course, the attack that should be taken. But, I do feel that there is still another problem which is involved in the entire system which has been ignored to a certain extent, and it is this: That an estuary or an estuarian system by its very development depends on the waters which feed it, and thereby form a salinity gradient which is of considerable extent. Any reduction in flow into such an area will reduce this gradient and make it a more sharp gradient.

I think the point that is missing in the studies which have been made to date and not the effect, let us say, of a particular toxic material or a particular substance upon organisms, per se, in their physiological adaptation, but I think the interactions which would result between populations in an area is an area which has been virtually ignored simply because I realize it is such an extremely difficult problem to predict and to work on even.

What I am saying is that the flows of water that enter from the San Joaquin and Sacramento system into our estuarine system are necessary for the maintenance of the present population. Whether you have a population composed of exotic organisms like we certainly have in the Delta region or whether you are dealing with endemic species, you have one thing in common, and that is that they are all organisms which have evolved literally on hundreds of thousands of millions of years in a high-flow, slack-summer type of environment, and I think the success, for example, of the early populations of striped bass is that they were originally introduced with almost entirely the characteristics of the Delta at that time. In other words, the floods -- all of these things -- certainly had their effect.

Now, the data on this is relatively slim, but in recent months some data has come forth, and that is what my exhibit is tonight, and I think this particular data will bear out some of this idea.

Let us take this one first which shows salinities that have occurred already in the area and in this case, during June and July, at Collinsville. At a previous time, the Department of Fish and Game attempted to make striped bass abundance indices for the area. They had very little luck in this regard. Then, they started to check the abundance of the inch and a half long fishes and plotting the Delta salinity in chlorides and parts per million, ranging from 3,000 to 2,000 to a thousand, and then taking the relative abundance index which is based on both the numbers of organisms caught in the particular area in the fishing time. With all of these taken into account in the region of the Delta, we see we have a line that has about -- in this case -- about a minus 10.92 K factor which gives us a correlation in the neighborhood of 1 percent.

So, this is important, but I do think that the salinities that we observe here are the result of outflows, and certainly we could tie in many other things with this type of figure. For example, it might be said that such a figure is taken at the present, under present situations that we have in the Delta, that it could be involved with the TDS which blocked migration, and certainly one will find that TDS in these lower areas for the

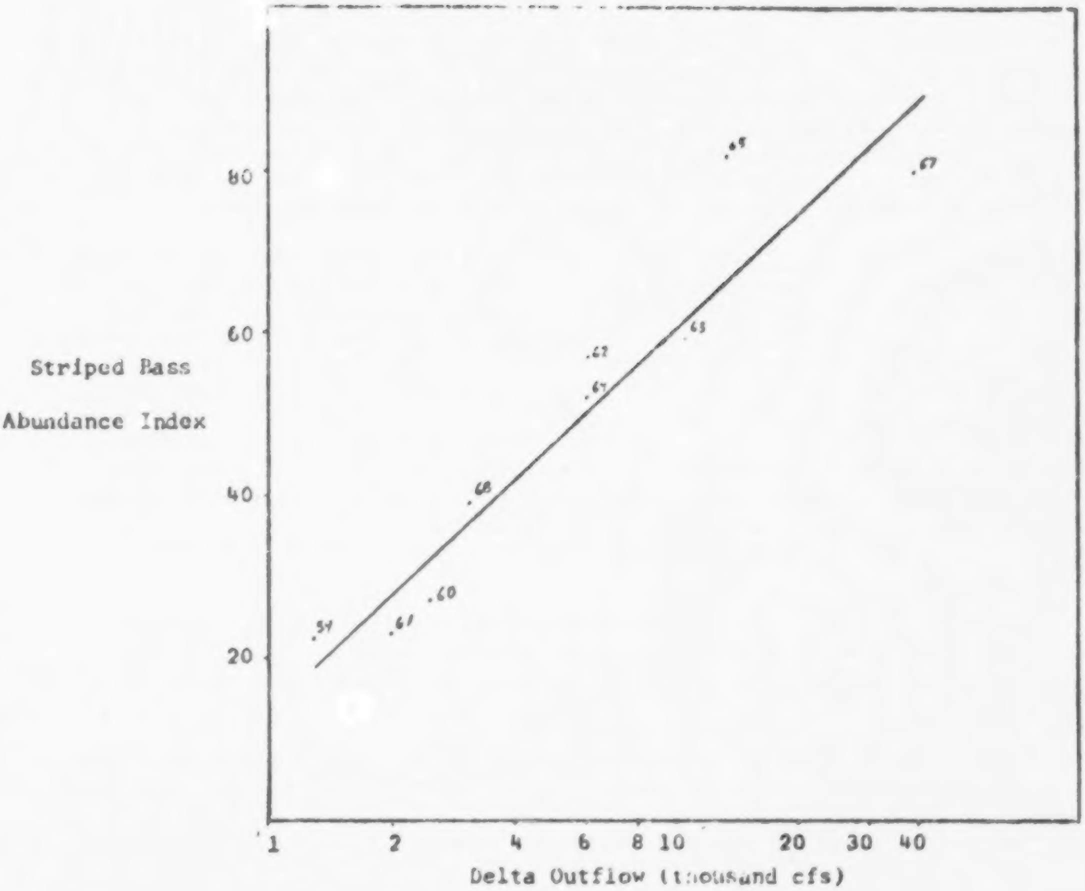


FIGURE 1. Relationship between young striped bass abundance and Delta outflow. Abundance is expressed as an index of the number of bass present in the Sacramento-San Joaquin Estuary when their mean length is 1.5 inches. Delta outflow is the June-July mean at Chipps Island as listed in the Department of Water Resources, Surface Water Flow Bulletins. Numbers on figure designate years.

Turner, Jerry L. and Chadwick, Harold K. Relationship of Young Striped Bass Abundance to Delta Outflow and Salinity: A Progress Report. Delta Fish and Wildlife Protection Study. October 10, 1968. (Figures 1 & 2)

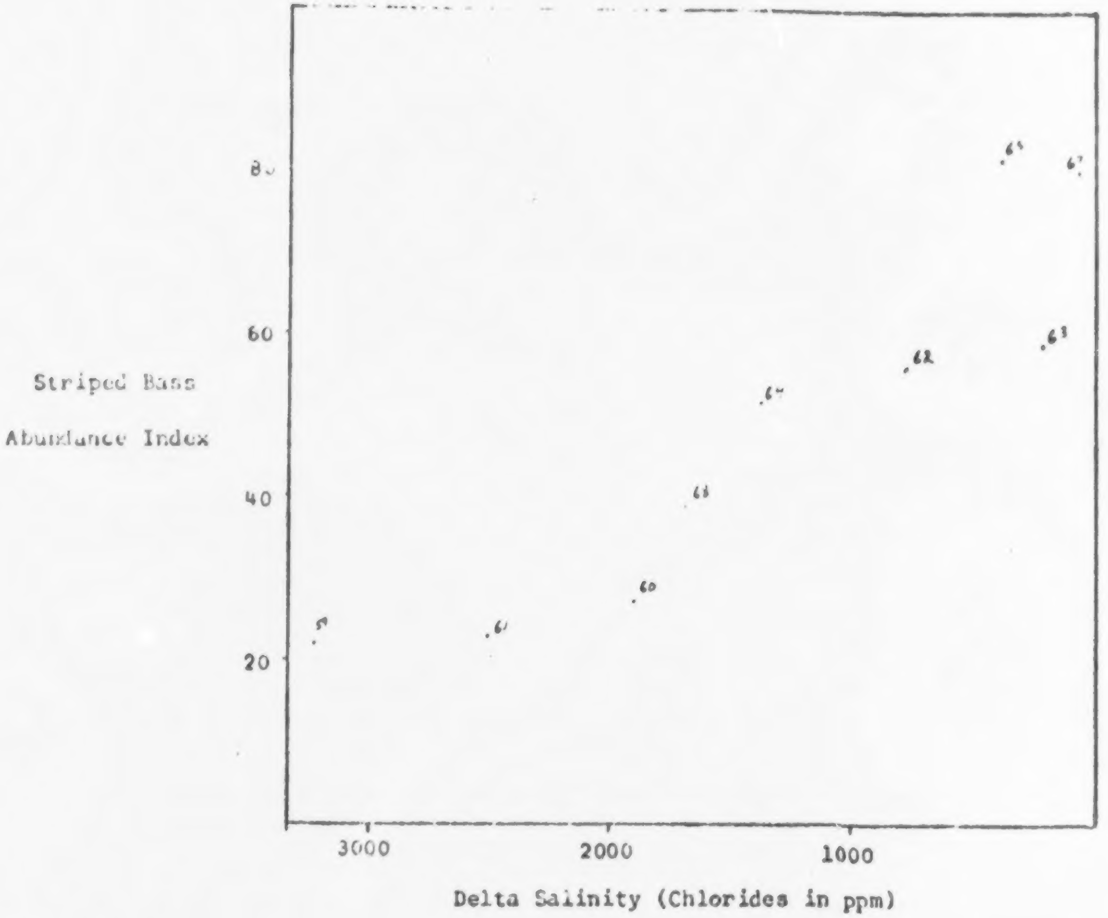


FIGURE 2. Relationship between young striped bass abundance and Delta salinity. Abundance is expressed as an index of the number of bass present in the Sacramento-San Joaquin Estuary when their mean length is 1.5 inches. Delta salinity is the mean June-July chloride concentration at Collinsville. Chloride measurements are grab samples and are reported in the Department of Water Resources, Surface Water Flow Bulletins. Numbers on figure designate years.

San Joaquin River were such that the migrations were blocked into that area.

I think this is not the whole story, that what we are basically dealing with is if we take the abundance index in relation to Delta outflow, we get this type of a figure which is a correlation of 0.94 K with Delta outflow of -- in thousands of cubic feet per second, 1, 2, 4 -- it becomes asymptomatic in this area simply because of the mechanism which is involved in the population production. However, here we are dealing with the possibilities -- despite the fact that this is present data, we are dealing with distinct possibilities that we have the results of, say, turbidity involved here which could have a food change relationship. The lack of turbidity at this end, let us say, would allow water transparency where the organisms were in cannibalistic forms.

We know from the studies that are done that one of the models that has been established for the demise of sardines takes into account the extended period which they are exposed to predation and, hence, high years; very limited predation, long years, or in years of long larval development, they are exposed for extremely long periods of time. Here we have a condition where possibly in these low flows during these periods of times that we are dealing with organisms which -- it could be this predation. It could be factors of this sort which are population factors rather than sheer biocides, pollutants, waste waters -- this type of thing. And, I think this type of information is the type of information that must be explored before we make statements about how much outflow are we going to allow.

This is Delta outflow during the months of June and July, and these are plotted against the organisms in July and August -- survival rate, if you will, in this respect.

I have done preliminary studies on this, and so far I do not find a great deal of correlation with the idea that it is due to these other factors that have been presented prior to this time, and I think the very nature of an estuarine situation, its turbidity in itself, is a factor for survival of those organisms. A very sharp gradient, for example -- I use this for an example, but we do not know that this same thing might not occur to other organisms whose life cycles may be intimately tied in with outflow, plus the fact we may be dealing with organisms which may be active predators, the flushing that does occur to them maintains their population at limits which will not prove harmful. Allow those large flushing flows to occur and occur during summer months -- these populations could possibly build up and have marked effects on other populations. I think this is one area that has not really been explored.

We have looked at it in terms of all the man-made effects on it other than the flow directly, and I think the flow is something that is -- something I know it is a difficult proposition to talk about when we are discussing also flows to be sent some other place, but I think that this is indicative enough that there should be real in-depth studies on this particular problem.

That is all I wanted to say.

MR. ALEXANDER: Going back to your first chart there, Dr. Tarp, that was at Collinsville?

DR. TARP: This is at Collinsville.

MR. ALEXANDER: If you made the same study and moved upstream to where you hit the thousand parts or the five hundred parts, followed the salinity upstream until you met that and then went ahead with the same test -- did you try that?

DR. TARP: I did not try this, and I did not do this work myself personally. It is under investigation at the present time, as I understand it.

MR. ALEXANDER: I was just wondering --

DR. TARP: I believe they have taken into account the abundance in areas dependent on how far they are away from, say, the centers of dispersion they would be in this particular time of month.

MR. ALEXANDER: Who is making this?

DR. TARP: The Department of Fish and Game of California.

MR. ALEXANDER: Have they completed this particular study?

DR. TARP: No, this particular work was first indicated in late October of last year.

MR. ALEXANDER: Are you acting as a consultant for them now?

DR. TARP: No, I am not. I am acting as a private individual who has lived here since day one, and I would like to have my children see it as I saw it when I was about four.

MR. McCARTY: Dr. Tarp, would you give us a little further definition of abundance index? Does that take into account given geographical areas?

DR. TARP: It takes the entire Delta system. They sampled the entire Delta. They weight the area -- the various areas are weighted. The catches are weighted. The types of nets which are used are weighted. All these things are taken into account, and from this, they derive an abundance and an index, and this is what this is based on.

MR. McCARTY: Are copies of these charts available on a smaller scale for transcript?

DR. TARP: I just made up this chart from materials, and the materials should be available from the Department of Fish and Game. If it is not, you can Xerox mine.

MR. McCARTY: Could we borrow those to photographically reproduce them?

DR. TARP: Yes. I do think this is such an important area that really has yet to be explored.

MR. McCARTY: You have taken the time to come here and speak to us on this particular point, and it would be a shame not to have them in the transcript.

DR. TARP: If you wish, I could write up a little thing and send it over with these on them.

MR. McCARTY: I think that would be helpful.

MR. ALEXANDER: Probably we should identify them as Exhibit 1 and Exhibit 2 as far as the charts.

DR. TARP: We did the salinity first and then the other one.

MR. McCARTY: If this would not be too much trouble, we would certainly appreciate it.

DR. TARP: No.

MR. McCARTY: You know that we will receive statements until the 14th.

DR. TARP: Yes.

MR. McCARTY: So, have it to us by then. If you find for some reason you cannot, simply give us the charts and we will photographically reproduce them and get it into the transcript.

DR. TARP: Thank you.

MR. McCARTY: Is there anyone else in the audience who would like to make a statement at this time either as a private individual or as representing an agency?

MR. PETER H. ZARS: I have several copies of our regular June Report here that we are finalizing now if you need them or would like them.

MR. McCARTY: This would be helpful as a part of the record. Are they available now?

MR. ZARS: Yes.

MR. McCARTY: Yes, we would like to have copies of those.

MR. ARTHUR L. OGILVIE: My name is Arthur L. Ogilvie. I turned in a card with the intent of making a presentation to you tomorrow, but inasmuch as you have asked if there are some people who would like to respond this evening, I would like to respond as a private citizen. My professional work is with Santa Clara County Planning Department. What I am going to bring to your attention is not in an official capacity, so I am speaking as an individual.

What I am going to state may be something that you people are wholly aware of, and then again, it may not be. It is something that has come to my attention in the last couple or three weeks that really shocks me very much. I think the best way to equate this situation is to sort of compare this type of water pollution or, I should say, better water poisoning -- the reason why we may have overlooked this is because you cannot equate it like you would air pollution.

If an individual plant or an individual were to put this kind of poison into the air, it would be so obvious immediately that he would be closed down within 12 hours. The situation that I am speaking of is forms of poison from man's cleansing methods. One example is laundries that hire itinerant contractors to haul off their waste waters, waste waters which, for example, the City and County of San Francisco will not allow to be discharged into the sewers, and it is my information or understanding that there are only two dumps in the entire Bay Area where "hot" waters are permitted to be dumped. I understand this is at Vallejo and Martinez, and the Warden for the County Fish and Game Department discovered the contractors crossing county lines and dumping it directly into the streams of Santa Clara County and, of course, this is in direct violation, and there has been investigation started.

He has called in representatives of the State Water Pollution Control and State Water Quality, but this has not been brought to the attention of the public in general, and I think it is something that we should all become aware of and the sooner we all become aware of it, the sooner we can fight this situation and put a stop to it and plug the loopholes in our rules and regulations and laws and perhaps be in a position to see to it and insist that the rules, regulations and laws are made to stop these situations.

In addition to this, since that particular episode, he has also apprehended another contractor doing similar types of dumping directly into the open waters that feed directly into the estuaries of South San Francisco Bay, and, as a result of this, he has gotten very alarmed and called a meeting with one of the State Legislators who is very interested in the water pollution control system and water quality.

He has also called a meeting of different contractors who contract to haul off these types of waters, and sitting down with them, he posed the question: "Is there association representing you people; do you people belong to an association?" It was his information from the gathering that there was no such association, so, therefore, there are no controls among themselves to police their own problems that they are causing the public.

The next question he posed to them: "How much do you people haul?" They looked at each other as if they did not know, and so they began to converse among themselves, and the figure was 30,000 gallons per day per one county, and in the instance of my asking him this question: "What about, say, for example, wastes from atomic or, I should say, radiological chemicals and so forth?" He said, frankly, he did not know, and he said he doubted whether they knew and he didn't even know there are AEC rules and regulations -- very stiff ones.

No one at this point seems to know whether or not this thing in many instances is not being dropped directly into our streams and going into the Bay. And so, I did a little mental calculating that if you want to equate this situation with the Bay Area and we have nine counties contributing, we have in round figures roughly 300,000 gallons of this poisonous material going into our Bay directly or trickling and eventually reaching the Bay in the great part from this type of operation, and there, for the first time to my understanding, there will be beginning some press releases and some publicity will start to go into the papers.

But, nevertheless, that is not going to stop it right away, and it means that people that can draw up such legislation and can foster such legislation makes it necessary for them to look into this matter and take the proper steps to see about it.

In addition to that, there are some other situations that are extremely critical, and I equate this to the fact that San Jose -- that area -- the public has been very representative as far as pollution controls are concerned, and the latest election in November -- both for San Jose and Santa Clara -- voted sizable bond issues for expansion in addition to their sewage disposal plants. And yet, some industries, whether it be people that are charged as far as supervision or the workmen, are unaware of what they are doing or it is accident, and, of course, accidents occasionally do happen, but still and all, when samples are taken and you find five times the amount of strychnines are going into the waters than is supposed to -- that fish, for example, can tolerate without dying -- what is this doing to vast areas for our estuaries -- and this is happening.

Another instance of a plant that is dumping great quantities of extremely toxic chemicals, metallic substances -- and when the question was raised about their dumping and so forth, you run into this ugly head of, "well so and so knows about that. He doesn't think that it's any great problem."

Unfortunately, due to the fact that this plant is a rather sizable employer -- well, you know how it is. It is that we will sort of kind of overlook this.

Well, I say personally it is time that we stop overlooking this because a company is a great employer and brings a lot of money into the community. I think that these are some avenues and things that we need to look at more closely. I know in the past that one of the Federal establishments in South Bay caused us some problems as far as dropping pollutants into one of the drainage channels which in turn got into the South Bay, and one or two of the speakers previously this evening mentioned this, and I think this is something that needs to also be looked into.

Tomorrow when I am here, I will be back and I will have another presentation, but it will be from our Department. Thank you.

MR. McCARTY: Thank you, Mr. Ogilvie. Do you have any questions, Bill?

MR. ALEXANDER: I am amazed at some of the statements that Mr. Ogilvie has made in regard to the industry and also to Federal agencies in that particular area. Have these matters been before the Regional Water Quality Control Board and the Executive Officer of that? Have you broached this subject with them?

MR. OGILVIE: This information that I have revealed here came to me from the Warden of the County Fish and Game Department -- Commission rather. And, at the same time, he has also been the Chairman of the Commission, and he came across these situations in his work or in his position rather. He feels he is in a position where he can do a great service to the County.

These things many of you perhaps or at least I, for one, have never stopped to think about -- this type of operation. You talk about septic tank pumpers and about them going out and cleaning out septic tanks. At the same time, it did not really occur to me that they might be in other activities going out and pumping out waste that could be detrimental.

MR. ALEXANDER: Well, there are county ordinances in many counties that I am knowledgeable on on this particular subject, and county officials, themselves, are taking care of it, and in some instances, of course, the Regional Water Quality Control Board is looking after it. I would like to have some more evidence along the lines of what you are talking about here.

MR. OGILVIE: Well, after the meeting, off the record, I will be very happy to give you the name of this gentleman, and if you would like to contact him, I am sure he would be very happy to cooperate with you and give you all the information he has on this matter.

MR. ALEXANDER: Thank you very much.

MR. McCARTY: Is there anyone else who wishes to make a statement this evening? If not, we will recess the meeting once again and reconvene again tomorrow morning at 9:15 a.m. Thank you for coming this evening.

(The Hearing was recessed at 8:40 p.m.)

...The Hearing was reconvened at 9:15 o'clock a.m. on Wednesday, February 19, 1969...

MR. McCARTY: My name is James McCarty, and I'm representing the Federal Water Pollution Control Administration. On my right is William Alexander, representing the State Water Resources Control Board.

We are reconvening our public meeting this morning. This will be the last in a series of sessions here in San Francisco, which began yesterday morning at nine o'clock.

For those of you who weren't here yesterday to hear the opening remarks, I will make a few brief statements before we receive more comments from various participants.

These public meetings are designed primarily to receive your statements, your views on the Nation's estuaries. In particular, we are interested in knowing what you think about pollution problems in the estuaries; the effects of these pollution problems on beneficial uses; the values of estuaries, the dollar values, the aesthetic values, personal values, recreational values that you might attach to the estuaries.

We would like to get your views on what you think the best uses of our Nation's estuaries are.

We would also like to particularly get from you any thoughts you may have on a system of management for estuaries: Should a local interest, State interest, Federal interest be related, or work together in managing estuaries.

Your views and comments will be recorded in an official transcript of this meeting and it will be made available for anyone interested in receiving a copy. If you haven't already done so, I would encourage you to register at the rear desk and put your name on the list, and one will be automatically mailed to you.

These transcripts will be sent to our Washington Office, where they will be collated, and a file collated transcript will be developed which is based on your comments and views.

One last point: Those of you who don't feel they can make a statement this morning, but would like to make some remarks for the record, if you would like to do this, if you contact Mr. Irving Terzich at the rear of the room, he will give you the details of the proper procedure.

Let me emphasize, anything that you want to put in the transcript, please remember that the transcript will appear in black and white, and anything in color will appear that way. You will have to realize this, and any remarks you have to make you will have to take this into account, otherwise your statement will appear unintelligible.

Would you like to continue any opening remarks before we continue?

MR. ALEXANDER: Yes, that I, too, want to welcome you here on behalf of the State Water Control Board. We are happy to be a part of these public hearings.

I would add -- mention another public meeting, this will continue in Los Angeles on February 25 and 26, in case there is anyone here that knows of anyone who would like to make a public appearance at that particular time. The Water Resources Control Board has been appointed by the Secretary of the Resources Agency, Mr. Livermore, to coordinate this particular study and see that all the preliminary reports are distributed to all interested agencies within the State, and then, if we receive the answers back so that the Resources Agency can report to the FWPCA, and have this information available for being forwarded to Washington for their final report.

That's about all that I have.

MR. McCARTY: Thank you, Bill.

Our first speaker this morning, for our first speaker, I would like to call on Congressman Jerome R. Waldie from the Fourteenth Congressional District of California. This takes in, I believe, Contra Costa County.

The rostrum is right there, I believe it's on.

CONGRESSMAN JEROME R. WALDIE: Shall I address myself to you or to the audience?

MR. McCARTY: If it's possible, the entire audience.

CONGRESSMAN WALDIE: I prefer to have my back to the audience.

Mr. McCarty of the Federal Water Pollution Control Administration, and the State Water Resources, Mr. Alexander; I think this is an extremely valuable exercise in trying to determine some of the problems connected with the preservation and conservation and protection of our estuaries in the United States, and particularly in California, and even more particularly in the Bay Area.

I suspect there are probably a few estuaries of the magnificance of the one that we are privileged to have in San Francisco's Delta Bay -- San Francisco Bay Delta Estuarine System, and I share the concern that so many people have undoubtedly already expressed before this hearing; that that Estuarine System is being rapidly depleted and destroyed by inattention in part, by lack of understanding of the effects of actions or reactions in terms of the estuary by fill, which is obviously dangerous to the Estuarine System, and by pollution, which is equally dangerous to the Estuarine System. Understandably, the concern with the Estuarine System and the dangers that can be done to it, generally stops with the consideration of the problem of fill and the problem of active pollution of the Estuarine System, but there's another danger to all estuarine systems throughout the United States, and particularly to our Estuarine System, and that was described in a study done by Mr. B. J. Copeland, entitled "The Effects of Decreased River Flow on Estuarine Ecology." He discussed the problem of what happens to the estuary when you build reservoirs and dams on the upstream sources of fresh water for the estuary, and diminishing the flow of fresh water into the estuary system; and he concludes that the practice of decrease in river flow by the installation of reservoirs is frequently followed without consideration or prior knowledge of the effects downstream, particularly in effects on estuaries produced by the balance of river discharge and the distribution of the sea.

With decreased river flow, the current system can be so altered that shoaling and coursing can set up completely foreign conditions.

I find the timing of this speech topic, The Rape of Northern Waters, to be somewhat ill-timed what with the recent record rains, the Sierra snowpack, their anticipated runoffs and the fact that some flooding has occurred here in the North.

It becomes quite apparent, in fact, that we in the northern part of the State have an abundant supply of water.

It is to the credit of this State's Water Resource Planners and Dam Builders that the facilities of the California Water Project and the Central Valley Project have prevented even more loss of life and dollar damage from flooding during this extremely wet winter.

However--I have not come before you today to praise the California Water Project. As a matter of fact I have no intention of even being kind to it.

I have come to bury the water project as it is today and to call on the State of California to make drastic changes in its outlook and its water export project so that the northern part of the State, and particularly the magnificent and varied waters of the San Francisco Bay - Delta Estuarine System, so blessed with a sufficiency of fresh water, will not become in fact a biological desert.

I fear that without more regard for -- and some means of protection for -- the Life Systems of the North -- in particular the San Francisco Bay Estuarine System -- the State will knowingly and by design sacrifice this unique and irreplaceable resource in order to meet its contractual and statutory water export requirements.

The most frustrating aspect of this entire problem is that there is no place to go in California, outside the courts, to get an even reasonably fair hearing on matters affecting the allocation of water resources. There is no administrative or quasi-judicial body, commission or agency in California that allocates water or adjudicates water controversies, that is not carefully contrived to arrive at predetermined judgments advancing the overall plan to export Delta water to the South.

I seek to prove to you today that if an area involved in a water controversy not a customer purchasing water from the Department of Water Resources and the State Water Project -- that area will not find relief or assistance from any State Agency or Board, when it is in conflict with a customer area.

I will show you how the role of the Department of Water Resources has changed from a conservation agency to a State-operated utility which is in the business of selling the State's Water Resources -- a role which is unique in all the fifty States.

I also intend to show how every State project affecting the San Francisco Bay-Delta Estuarine System is designed solely to benefit the Southern users of the California Water Project -- customers, if you will -- of the Department of Water Resources -- with only incidental benefits to the Bay-Delta area.

Let us first examine the most unusual and highly questionable role of the Department of Water Resources. Until empowered by the Burns-Porter Act of 1959 to do so -- the Department never engaged in the act of marketing what it was constitutionally charged with protecting -- the State's precious water resources.

With the passage of the Burns-Porter Act by the Legislature and I was one who voted against it -- the Department of Water Resources was mandated by the Legislature to sell -- not protect -- these resources. This change in mandate has resulted in the Department becoming totally customer-oriented. Thus we see the

Department stooping to such indignities as suppressing reports of such agencies as the Department of Fish and Game if those reports in any way cast doubts on the means or plans designed to attain the Department's single goal of providing the contracted amount of high quality water to its customers in the San Joaquin Valley and Southern California.

The estrangement between the Department of Fish and Game and the Department of Water Resources began soon after the placing of all the natural resource agencies of the State under the all-encompassing Resources Agency.

It became apparent that the Resources Agency was aiding and assisting the Department of Water Resources in its export business when budget time came around.

Studies for fish and wildlife enhancement and preservation in the Delta were blue-penciled whereas State monies for unauthorized projects essential to the export business of the Department of Water Resources such as the proposed Peripheral Canal, were approved.

One budgetary axing in particular is indicative of how strongly the Department feels about its obligation to export Delta water to its Southern customers even though adverse consequences may thereby ensue to the Bay-Delta area.

In October of last year a preliminary study by Fish and Game Department biologists discovered a sharp correlation between salinity and fresh water outflow and the mortality of young striped bass in the Delta area.

The study revealed that the number of striped bass young surviving in midsummer is directly linked with water outflow from the Sacramento and San Joaquin Rivers--and the relationship has a significant implication for water development programs in the Delta such as the Peripheral Canal.

In short, the Fish and Game Department concluded that the reduced outflow and resultant higher saline content of the water would result in a drastic and intolerable reduction in the striped bass fishery.

Seeing the great significance of this finding, the biologists attempted to enter the preliminary report in the already prepared task report of the Bay-Delta Study--part of which was being written by the Department of Fish and Game.

However--this most important finding was not included in the preliminary report text--even though it was a new facet of the

Bay-Delta ecology with dramatic new possibilities for further study.

Shortly afterwards the Department of Fish and Game learned that a further study of the effect of reduced outflow on the striped bass fishery was slashed from the Department's budget by the Resources Agency and the Department of Fish and Game was forced to apply for funds from a Federal agency and a private foundation. It would appear, then, as if the State of California does not want to learn whether or not its water exportations via the Peripheral Canal will devastate a thriving sports fishery and recreational facility--despite indications that this could very well occur.

The Fish and Game Department was given a stunning rebuke by the Water Resources Director just recently when three fish and wildlife experts from the State of Washington were hired to conduct a study on how to operate the Peripheral Canal to protect the fishery--despite months of negotiations with the State Fish and Game officials on the same matter--negotiations which broke down after the Department of Water Resources refused to accept facts that would jeopardize its export plans.

It is my feeling that the Department of Water Resources and its Director, Mr. Gianelli, have stacked every major decision-making Water Agency of importance in the State with persons having direct allegiance to water customers of the Department--especially the Metropolitan Water District of Los Angeles.

As an example of this contention, since the creation of the California Water Plan, the State Water Rights Board and the Water Quality Control Board were lumped together as the State Water Resources Control Board.

Thus the single most important agency for resolving disputes as to the allocation of the State's Water Resources is no longer impartial--and we have learned from repeated experiences before that Board that a non-customer of the State cannot expect to get a fair shake before it if his dispute involves a water customer of the State.

In my opinion one only has to look at the background of the men who comprise this Board to see the built-in conflicts of interests that must result.

Let us first consider the Chairman, Kerry W. Mulligan. Mr. Mulligan, although admittedly a Northern Californian, was until January the Executive Officer of the Board. His complete allegiance to the water export policies of the Department are very well known.

Board Member, Edward F. Dibble, another appointee of

Governor Reagan was at the time of his appointment Manager of the San Gorgonio Pass Water Agency--a customer of the State--and Engineer and Manager of the San Bernadino Valley Water Conservation District--another area to receive northern waters. He has served as President of the California Water Resources Association--a leading agriculturally oriented organization supporting the shipment of good water at low prices to the undeveloped south.

Board member Norman B. Hume was another appointee of Governor Reagan with Southern California water user roots. At the time of his appointment, Mr. Hume was serving as Director of the Bureau of Sanitation of the City of Los Angeles.

William A. Alexander joined the newly-formed Water Resources Control Board at its inception in 1967 having formerly served on the State Water Rights Board since 1961. An Engineer, Mr. Alexander had been employed by the Department of Water Resources, the U. S. Bureau of Reclamation and the Corps of Army Engineers. He has served as Chief Engineer, Manager and Consultant to a number of lower San Joaquin Valley Water Districts.

Lastly we have George B. Maul, an appointee of Governor Reagan who voluntarily stepped aside as Chairman of this important and powerful Board to make way for former staff member Kerry Mulligan after the only voice of the San Francisco Bay Area, Ralph J. McGill, was not reappointed to the Board. Maul, an Attorney has served as General Counsel for the El Dorado Irrigation District and has provided legal services for other irrigation and water service districts.

One can readily see the difficulty of arguing the cause of the non-customer bay area for retention of Bay-Delta waters when such a decision would limit the ability of the Department of Water Resources to export Delta water to its customers--or--would increase the cost of export waters to its customers.

Our problems here in the San Francisco Bay Estuarine System are further compounded by the fact that every facet of the California Water Plan affecting this system is designed not to protect the Bay-Delta system but to speed high quality Delta water to the South with the utmost efficiency at the cheapest cost and with little regard for the consequences of this policy on the Bay-Delta system.

Let us use, for example, the proposed Peripheral Canal--the Canal, a 43-mile long, unlined conveyance facility, will divert a major portion of the Sacramento River near Hood and transport water along the eastern periphery of the Delta, and terminate in the Clifton Court Forebay in the southeastern corner of Contra Costa County.

The menace of the Peripheral Canal, as far as we in Contra Costa County are concerned, lies with the fact that the Canal is a physical facility which gives virtual control of the entire flow of the Sacramento River and Delta to the U. S. Bureau of Reclamation, and/or worse, the State Department of Water Resources.

We have been assured by Mr. Gianelli and others, that the Canal was principally designed to convey high quality water to the project pumps at Clifton Court at the same time protecting the Delta fishery by reducing the pumping of free floating striped bass eggs and fingerlings directly from Delta channels during the spawning season.

This is what we have been told--but there are a growing number of persons who are understandably worried over the assurances of the Department on this or any other matter. In fact, there are those of us who believe the Canal has no benefit for the Delta but is solely for benefit of Los Angeles, etc.

You see, the fishery problem will not be solved by the Canal unless adequate releases are made out of the Canal westerly and into the Sacramento River.

To date the Canal is a nebulous thing without operational agreements with the Department of Fish and Game, without an assignment of responsibility as to whether the Bureau of Reclamation or the Department of Water Resources will operate it--and most importantly--without statutory provisions guaranteeing fresh water releases to meet an as yet unsettled water quality criteria--even though contractual commitments with downstream water users would have to be sacrificed in dry year cycles.

We fear that almost the entire flow of the Sacramento River will be diverted southward and that once the tap is turned on for Southern California--we in the Bay and Delta areas will not be able to turn it off--with tragic consequences to the Bay-Delta area.

The Federal Water Pollution Control Administration has evaluated the proposed Canal and concludes that it will materially downgrade the quality of Delta water.

The Federal Water Pollution Control Administration report warned that if the Canal were operated at water quality criteria proposed by the State and the Bureau of Reclamation it would have a very significant detriment to the Delta's agriculture and also its fishery. When we talk about water quality we really are talking Delta outflows.

There is great concern as to what effect the diversion of a tremendous amount of existing fresh water outflows will have on the life systems within the San Francisco Bay Estuarine System.

I am especially troubled because State Officials and Engineers preparing the Bay-Delta Study Report, with rare candor admit that they themselves do not know what will happen to estuary ecology given decreased Delta fresh water outflow.

Certainly, the wetlands of estuaries such as the San Francisco Bay-Delta system don't appear to be a great natural resource with their smelly and musky marshes. As one writer put it--"They have neither the majestic grace of towering pines nor the stark beauty of a desert.

"This is one reason they are so readily squandered--nobody loves a swamp."

The dangers to estuaries such as our own Bay-Delta estuary activities as filling and pollution with industrial and sewer wastes is well known, and the Bay Conservation and Development Commission has alerted the public to these dangers.

But there is a third and no less important threat to the Bay and the estuarine system that supports it -- that of the dimunition of fresh water outflows caused by the State exports of Sacramento River water to the South.

This is especially dangerous as the intricate current system within estuaries is produced by the balance of river discharges and the contribution of the sea. With decreased river flow the current system can be so altered that shoaling and scouring can set up completely foreign physical conditions.

The most important hydrobiological parameter in an estuary is salinity--if river flow is restricted by upstream diversions, the salinity level in the receiving estuary may increase to the detriment of estuarine biological communities.

Marine life, much as freshwater life, lives precariously close to the doorstep of death. The slightest change in the environment often spells doom for an entire specie; in estuaries the chemical content of the water has critical and narrow limits.

Important fluxes occur in the estuarine ecosystems during the high flows of spring and fall including flows of vitamins and other dissolved organic compounds, nutrients, lowered salinity by the addition of fresh water and flushing and mixing influences.

Looking at the proposed reductions of freshwater outflows planned by the State we can only deduce that the San

Francisco Bay-Delta Estuarine System is in for a drastic change.

The present flows into the Bay are comprised of 70 percent from the Sacramento River, 20 percent from the San Joaquin River and 5 percent from other tributaries--outflows now total some 17.8 million acre feet per year on an average.

Under the provisions of the State Water Plan this figure will be reduced to 9.4 million acre feet by 1990 and 7.2 million acre feet by the year 2020. These are Department of Water Resources figures.

Other statistics furnished by the Contra Costa Water Agency reveal that this outflow could be reduced to as little as 2.5 million acre feet in a dry year cycle.

Not only is this 60 to 70 percent cut in the quantity of fresh water entering the Bay a factor in ecological change--but the manner by which the cut will be implemented should have a profound and probably adverse effect on the Bay life systems.

Freshwater outflows will amount to a steady, regulated, unvarying meager 1,700 cubic feet per second nine months out of the year with only January, February and March seeing anything even remotely approaching the normal fluctuations that now characterize the estuary outflows.

The effect this artificially induced regularity will have on marine life accustomed to the variance and diversity of present freshwater outflows can be assumed to be of considerable impact and mostly negative. Life in an estuarine system is wonderfully complex--to "harness" that complex diversity is to risk its serious alteration, if not its extinction!

The reduction of outflows can also be expected to cut down the flushing action of the North Bay as well as allowing harmful saline water intrusion into the western Delta area.

The best flushing action presently in the Bay is in the northern section where Delta outflows contribute necessary oxygen-bearing waters to aid in the reduction of waste and hydraulic circulation.

The worst flushing is in the South Bay where the absence of inflows and circulation leaves water rocking up and down as if in a tub with very little movement of pollutants. The result has been the occurrence of frequent eutrophication or algae blooms which absorb already scarce oxygen and results in death of fish and other marine life.

I have just made some assumptions on the effects of diminished freshwater inflows into the San Francisco Bay Estuarine System--assumptions based on available data that indicates such dimunitions would have a detrimental effect on existing life systems.

May I point out that the Department of Water Resources and its Director, Mr. William Gianelli, have also made some assumptions as to what will occur with a reduction in freshwater outflows. His assumptions--however--are that these drastic changes will not have detrimental effect.

I would suggest that if the full effects of such a change in the most important biological factor of a huge and diverse life system is unknown--then we should proceed with all due caution and restraint.

I suggest that we experiment on the side of caution and see if our experimentation results in detrimental effects. If so then we can proceed without destroying all present life.

To do the opposite--as I fear is the intent of the Department of Water Resources--would be a great error. And one that may not be reversible.

I am in favor of a moratorium on water development and the proposed shipment of water to the southern part of the State until we know through new research and study what effects this proposed export of northern water will have on the ecological systems of the North--especially the San Francisco Bay Estuary.

I wholly concur with results of the recent vote taken by the Commonwealth Club of California where an overwhelming majority favored increased control over utilization of San Francisco Bay and also favored retention of the present boundaries of the Bay.

I propose that the State Legislature authorize a completely new water resource and development agency. An agency with statutory checks and balances to provide the groundwork for workable development and careful protection of environments and ecology systems.

This agency would carefully inventory our water resources and determine where they would best be used. It would by law be charged with the responsibility of conserving and protecting our water resources--not exploiting and selling them. It would be above the political entanglements that have seen such agencies as the Metropolitan Water District stretch out over vast areas of the State and control the water resources of that area for the use of its customers.

I propose that the State Legislature also constitutionally create an independent agency formed along the lines of the Tennessee Valley Authority to act as the purveyor of State waters. I am convinced that the State should not be in the business of selling water. The evils of the present situation in Sacramento are apparent--they should not be permitted to continue.

I propose that the State Legislature amend the Burns-Porter Act so that the aforementioned changes in the structure of the Department of Water Resources can be implemented as soon as possible.

I propose that with a review of the California Water Project the State work to meet its contractual requirements to the South and its moral requirements to the North not by the further rape of North Coast waters--but by improved technology.

The use of reclaimed water is one method eyed as a substitute for the uneconomical and wasteful transmission of water over 500 miles for domestic use.

Workable desalinization of sea water is within our grasp. Costs will be high at first--but this is the way of the future. I have no doubt in my mind that this will be the cheapest way to provide fresh water for coastal urban centers before 1990.

Water reclaimed from sewage in Southern California has been developed at a cost comparable to water of the California Water Project and of better quality than that shipped from the Colorado River.

Are we to ignore the technology of the present and the future for the plumbing of the past?

I think not.

We must act now to protect our own environment, our Bay, our Delta and our North Coast from the ruinous plans of the water-hungry south and their minions in Sacramento.

I pledge to you here today that we in Contra Costa will continue our lonely fight to assure adequate water quality in the Bay-Delta System. I would hope others would join us.

We--the extremists as Mr. Gianelli refers to us--will do everything possible--including a massive suit that could tie up the water project for years--to make certain that our unique estuarine system does not turn into a black biological desert.

We will continue the struggle to protect the waterfowl, the wildlife and the fisheries of our Bay and Delta and of the marvelous wild rivers of the North Coast.

We have seen what an active and aware public can do for conservation. I refer to the outstanding work of the Bay Conservation and Development Commission and its efforts to alert the public to the threats of Bay fill.

We need a similar agency to protect the environment of the entire Bay-Delta System--not just from fill and sewerage--but from all the ill-effects of mankind upon his own environment.

We now see the people of the Santa Barbara Coast rightfully enraged over the spill of oil from approved offshore drilling operations. Operations approved because the West Coast allegedly needs more crude oil--but operations that were known to be taking place in an area of high seismic activity. The tragedy of that administrative act has yet to be fully calculated.

But it will be only miniscule as compared to the ultimate effects of the California Water Plan--quite possibly the most costly and dangerous environmental disaster occurring in our State.

Let us take stock and then proceed--but we must not blindly go on--we may not survive such a mistake.

MR. McCARTY: Thank you.

MR. ALEXANDER: Congressman Waldie, I had a question or two. First on this Copeland report, do you have a copy or could you tell me more about it as to when it was written and what it covers?

CONGRESSMAN WALDIE: Perhaps my -- Mr. Newcomb, do you have the data Copeland prepared? We can get it to you, we can get it from the Library of Congress. It's a fairly recent report.

MR. ALEXANDER: Is it on a certain estuary?

CONGRESSMAN WALDIE: No, it's on all estuaries, although it just -- if I recall, for Chesapeake Bay and the Galveston Estuarine System. He used those, as well as -- Galveston particularly as a horrible example of what man can do to estuarine systems and used the Chesapeake Bay as a possible example, although they imagine it's so huge, and the development around it, as far as that, man hasn't had much opportunity to destroy that.

This is the beautiful example in our system, where man is surrounding it and destroying it.

MR. ALEXANDER: What is Copeland's background on that, is he an ecologist?

CONGRESSMAN WALDIE: I'm sorry, I should know those things; I don't.

MR. ALEXANDER: But, you could send us a copy?

CONGRESSMAN WALDIE: It was a Library of Congress resource, but it appears to me that it was -- it's a University publication, but I'll send you a collection of texts.

MR. McCARTY: While we are on that one question, would you care to have that made a part of the record?

CONGRESSMAN WALDIE: I sure would, because I don't know if anyone is going to be talking about this in terms of the hearing, the decreased flow of water into estuarine systems, it's just as damaging as pollution and just as damaging as fill to the estuarine life system.

MR. McCARTY: I will get that into the record.

MR. ALEXANDER: Congressman, I had the opportunity to sit in on both of the hearings on the water rights within this Delta, and of course, this matter of steady state conditions which you referred to quite extensively here, was one thing that we are in habit of taking under consideration and other things, as coordinated operational agreement, because you just don't have the transportation data. You have the Federal Government involved in exporting water from the same particular location, and the two agencies, at the present time, are coming up with a coordinated operational agreement that would have to be reconsidered when the hearing is opened at one time, along with the water quality portion and the salinity within this Delta, and all of those matters are still to come, and we'll be hearing a lot on it probably this coming July.

CONGRESSMAN WALDIE: Well, I hope so; you will surely be hearing from me on it.

MR. ALEXANDER: Well, I realize that.

CONGRESSMAN WALDIE: The reservations that I have, Mr. Alexander, it's -- I was at the October 21st hearing, and he -- Mr. Gianelli, one of the Directors, got a copy of the transcript, the Peripheral Canal cannot be operated with any --

MR. ALEXANDER: In the session of November 14th agreement, which is a 1700 figure?

CONGRESSMAN WALDIE: Well, that's so, and I suspect it's so, you can understand my misgivings about any opportunity of going to a -- any agency of the State or commission of the State and hoping for an adjudication of a resolution between a customer and a non-customer. And, as I said, the obligation to different water customers does that.

MR. ALEXANDER: What I was trying to put out to you, that hearing that was held in October is not the Water Rights Hearing. The Water Rights Hearing was held prior to that particular time.

CONGRESSMAN WALDIE: Walt G. Norris's testimony was taken, yes, but we did leave it for further consideration. We left this open as far as the water quality is concerned, but I did not fight against Mr. Gianelli, he left it to one of an additional outflow; he said an additional outflow approved on the November 19th agreement is not permitted or possible. That's what his testimony was.

MR. ALEXANDER: The terms and conditions that we're going to have to operate under, as far as this, it will be set for the -- by the State Water Rights Board has not finally been determined, and I think, just as you've testified here today, that it's going to mean a continuing jurisdiction, to see how these things are going to work.

Maybe this winter's low tide is not flushing, maybe you have to put another month in there, and there's many questions to be resolved, and I don't know where we can turn to in any place in this world, or in the United States, and operate a system, an estuarine system such as this to show any person. I think it's something that has to be worked on, sort of a trial basis; so all the beneficial uses can be covered.

CONGRESSMAN WALDIE: I would concur totally in that statement if you would qualify it by saying while you're trying, and while you're erring, you'll err on the side of conservation, not on the side of exporting.

MR. ALEXANDER: Well, that's what I would hope.

CONGRESSMAN WALDIE: In other words, you would have flows coming into the estuarine system that you -- greater than you think might reasonably be required; then, if you find you don't need them, you can decrease it, rather than start out with decreased flow, then find things may be irreversible.

MR. ALEXANDER: Congressman, that is the way I view it. At the present time, when you take the amount of water that's available in this system and the amount that's going to be used for the next 10 to 15 years, we have a surplus of water, in most instances, all the way through, that can be worked back and forth; but in the next 10 to 12 to 15 years, with all the resources and everything and the demand not picking up until a later date, you have an opportunity to do some of that. That's why we maintain in practically every one of our water rights decision this continuing jurisdiction. And, this estuary here is one of the most important, because it is the spot where all of the exporting is being done, not only to Southern California, but to the central part of the State.

**CONGRESSMAN WALDIE:** Well then, I would feel much more comfortable if the words you were using were coming from Mr. Gianelli's mouth.

**MR. ALEXANDER:** Mr. Gianelli is working the same as your Bureau of Reclamation; Mr. Gianelli is exporting water, in charge of the State, and the only agent would be this -- your State Water Resources Control Board, we as both water rights and water quality transportation.

**CONGRESSMAN WALDIE:** But, you make an assumption that I am not willing to make a deal, and that -- it's an independent agent, I would venture a speculative guess that I will hope to be able to be more definitive about that.

The members of that Agency are heavily weighted to customer-oriented and customer-conflict of interest; full membership, but members on that Board who are adjudicating disputes between the allocation of water resources in the State of California of their allegiance, and their obligation to the water customers of the State.

**MR. ALEXANDER:** Well, of course, I would have to differ with you, Congressman Waldie, I think that the members of the Board are representing the people of the State as a whole, and all of the beneficial uses of the water of the State, we hope.

**CONGRESSMAN WALDIE:** I would feel very comfortable if I could accept that, and I have not yet, and I don't mean to be --

**MR. ALEXANDER:** I understand.

**CONGRESSMAN WALDIE:** I am going to present this thesis that I've just mentioned to you in greater detail, Friday, before the Commonwealth Club, and I would hope that I'm proven absolutely wrong, and this Board to which you refer is independent, and that the misgivings I have about giving that Board or any administrative body in this State any jurisdiction over anything else to do with water, that those misgivings are unfounded.

I would be terribly alarmed if I had to go before your Board and Mr. Gianelli. Already, a resolution of the problem facing this estuary; if they required the reversion of the water from the Delta to resolve those problems, wouldn't you find that to be a very difficult decision to make; if reversion -- that you don't deliver to Southern California according to your contract, could you even break your contract?

MR. ALEXANDER: Well, you're talking about the Department of Water Resources; as far as the Water Resources Control Board, we have no contract with anyone, and having been a member of both Water Rights Board and this new Board for about approximately eight years, we have had no one in authority telling us how to operate; and we are most independent.

CONGRESSMAN WALDIE: That you've been one of the most independent and one of the most effective, I'm not able to say that with equal certainty about some of your colleagues.

MR. ALEXANDER: Of course, I'm the only one here.

CONGRESSMAN WALDIE: Thank you.

MR. ALEXANDER: Well, we thank you for your statement.

CONGRESSMAN WALDIE: Anything more, Mr. McCarty?

MR. McCARTY: Thank you very much for taking your time from what I'm sure is a very busy schedule.

For our next speaker, we have Mr. John DeVito representing the Contra Costa County Water District.

Mr. DeVito.

MR. JOHN E. DeVITO: Mr. Alexander, Mr. McCarty, Congressman Waldie, Gentlemen: I would like to read my statement, if I may, and I may by your leave also depart from time to time as certain thoughts occur to me that will be beneficial to your survey.

The Contra Costa County Water District relies entirely on water diverted from the rivers and sloughs which constitute the Sacramento-San Joaquin estuarine system. It is my purpose to first acquaint you with the District's use of the estuarine system, and secondly to comment generally on what we believe the future use of the system should be and comment briefly on guidelines for developing a management system.

District's Use of the Estuary -- The District was formed in 1936 to distribute water from the Contra Costa Canal which was built by the U. S. Bureau of Reclamation as the first unit of the Central Valley Project. First deliveries began in 1940. Present-day deliveries total approximately 90,000 acre-feet per year and represent the primary source of water for seven cities, many industries and rural areas. Exhibit A shows the extent of the District's service area of 109,000 acres. Assessed value is $649 million and population is crowding the 250,000 mark. Deliveries are expected to grow to 178,000 acre-feet per year, that's within the next 10 to 12 years, as indicated by a Master Plan recently submitted to the District by consultants, a copy of which has been brought for insertion in the record.

The source of supply for the Contra Costa Canal is Rock Slough, one of a multitude of intertidal sloughs which together make up the intricate Delta complex. Rock Slough is approximately 75 water miles from the Golden Gate and is at the fresh-water end of the salinity gradient which is presently prevented from intruding harmful distances upstream into the rich agricultural and export pool area of the Delta by releases from upstream storage projects.

I would like to point out that the diversion from Rock Slough, although initially intended for primarily agricultural purposes or historically, will be used according to a separation of about 90 percent or more municipal and industrial use, and 10 percent or less for agricultural use.

Exhibit B attached lists historic annual diversions at Rock Slough. Exhibit C shows diversion water salinity concentrations experienced in 1959, 1961 and 1966, and Exhibit D shows the availability or days per year that a given level of salinity was not exceeded based on analysis of records dating back to 1945. It is of interest to note that water with a chloride ion concentration less than 100 parts per million (the State Water Project's Delta export quality objective for the average month is 110 parts per million). Now this concentration of 100 parts per million exists 65 percent of the time, or about 237 days in the average year. Since over 90 percent of all deliveries are put to municipal and industrial purposes, a higher availability average is desired. Furthermore, although exceedance of the U. S. Public Health Drinking Water Standard of 250 parts per million, that's in chloride ions, has been relatively infrequent, it has happened twice in the last 10 years; once for 28 days in 1959 reaching 347 parts per million and again in 1961 for 23 days reaching 286 parts per million. This whole thing, the Contra Costa Canal and allied health service, in 1960-62, as part of the Kellogg investigation, showed that as this water in the Contra Costa Canal System exceeded 100 parts per million, the water users experienced what your report calls "penalty costs" that averaged three times the original cost of the water; and individual uses, the average additional penalty cost to treat that water through the industrial process, ranged from 100.50 per acre feet to over $220 per acre feet, puts it for every part per million of chloride ions existing on the coast for some years.

The District also derives water from the estuary at Mallard Slough. Now, I would like to concentrate on the estuary diversion at Mallard Slough, an adjunct of the Sacramento River system just south of Chipps Island, also the westerly end of the legislative-described Delta. Mallard Slough is approximately 46 water miles from the Golden Gate. The salinity gradient is extremely mobile at Mallard with fresh water being available for varying periods each winter and spring and high salinities normally reaching 3,500 parts per million each summer. Diversions at Mallard Slough which predate Rock Slough diversions, date back to 1930. The Mallard pumping facilities and water rights were acquired in 1961 by the District from a private water company serving the central county area. You asked for dollar indications, the best we can determine, at this point in time, is it was well over a million dollars for that particular facility.

Exhibit E shows annual diversions at Mallard and Exhibit F shows the days each year that salinities remained below 100 parts per million chloride ion concentration, the District's limiting diversion criteria. The overall average is about 142 days per year (39 percent of the time).

The foregoing describes the District's use of estuarine waters, it will be of interest for you to note that in addition, some customers of the District in the municipal and industrial class, all located upstream of Mallard Slough, also divert estuarine water. This water must be viewed in terms of quality restrictions dictated by the use to which it is put. Exhibit G is a tabulation of these diversions. Column (1) shows diversions of good quality water (generally less than 100 to 150 parts per million chloride ion concentration) for municipal and industrial process uses. Such water is available only on a seasonal basis. Column (2) shows diversions for cooling purposes, the predominant volume of which generally has no mineral quality restrictions and is available year-around.

Now, may I qualify at this point: Our actual records indicate that even though it isn't a major percentage of the total amount of cooling water, there are cooling water restrictions or cooling water limits that are certainly germane, and are of particular concern to individual industrial water users. By example, we notice that some industrial cooling water uses cannot exceed 500 parts per million in some cases; they can exceed 500 parts per million in some cases. They can't exceed a thousand.

The canneries for certain process purposes cannot exceed a thousand parts per million. This is something, of course, that should be pointed out, even though it isn't a majority of the total.

Finally, it should be pointed out that aside from natural rainfall the foregoing estuarine diversions represent essentially the entire water supply for lands within the District. Ground water quality is poor and quantities derived from this source are relatively small and can be neglected and there is no significant surface water development of the relatively meager 15 inches of annual District rainfall. With this in mind, the dependency of the lands and inhabitants within the Contra Costa County Water District on the estuarine supply becomes abundantly clear.

Future Use of the Estuary -- The following comments are generally limited to that portion of the estuarine system upstream of Carquinez Straits. I would like to add here that records established by the old industrial association under the guidance of the late Tom Carlson and Carl Shaddler, show that prior -- at one time the dividing line between salinity and fresh water was the Carquinez Straits. This by way, at the historical steps of the marina seawater aquatic life on the seaside or west side of the Carquinez Straits and freshwater activity on the upstream side. I think those records are available.

The District has long recognized that water quality standards should be set at levels sufficient to protect the environment (both water and water related) for fish, waterfowl, recreation and aesthetic needs. Water quality needs of the rich farmlands of the interior delta area must also be protected. In the westerly reaches of the Delta, the District has long agreed with the concept that the protection of existing diversions for municipal and industrial purposes is an economic question and must be balanced against the next least costly alternative, namely replacement via an overland export system extended from an area of assured quality, and we've often referred to Section 100 of the Water Code in this respect; and it has been pointed out canal water quality needs improving. The adverse effects of the 1959 and 1961's when summer intrusions caused extremely high salinities must definitely be avoided. To overcome this deficiency (and others I will not go into at this time) the District in 1961 supported authorization of the proposed Federal Kellogg Project which would import water of good quality from the Tracy area in the south Delta. This same project could well serve to also convey replacement supplies.

The concept that the District very definitely opposes is that the economy of replacing existing diversions is decided upon and longer term intrusions permitted without first authorizing the very vehicle (project) which makes the concept work. So here we stand. Not only is Kellogg not authorized for its own merits (benefit/cost ratio excluding any replacement supply concept allocations is 2.28/1.00) but further it has not even been sent by the U. S. Bureau of Reclamation on to Congress for consideration and this after nine agonizingly long years. Under the Bureau of Reclamation, it might be like 90 years, water years, and to our years. But, we checked with the Document Division this morning, it's really eight years six months that we have been waiting for this report. The Bureau of Personnel tells me that this particular preparation of a feasibility report breaks all records in terms of length of time.

My point then is this, fish, waterfowl, the recreationist, sightseers, etc., must not be left the legacy of a polluted water system and the environment must certainly be protected. Delta agriculture must also be protected. In addition, existing western Delta diversions requiring good quality water must be protected until the projects which can wheel replacement water of good quality are approved -- already funded.

The flier for this meeting also inquired as to management and before closing, although having no specific organizational recommendations at this time, I would like to comment briefly to this point. Implementation of standards and management of a system that will protect beneficial estuarine users must recognize several basic truths:

(1) The storehouse of knowledge regarding just what standard will in fact accomplish a stated goal is limited and although presently getting a lot of attention, it should be recognized that any regulatory body must be equipped with professionals well versed in the many and varied disciplines required, biologists, engineers, economists, recreation experts, etc.

(2) The need for continual updating and review of standards as new knowledge is acquired is necessary and the mechanics for accomplishing this should be worked out and readily available.

(3) The problems of estuarine environment are truly regional in scope. Agencies concerned with the lower bays cannot divorce their thinking from what happens in upstream estuaries and in the Delta and vice versa.

(4) The governmental agencies that can regulate parameters having a significant effect on the system (such as water flow) must be required to cooperate to do their share to make the system work.

I would like to add a fifth here on dollar values. If I can draw your attention to the table on Exhibit G -- well, first, let me go to Exhibit E which are our own historic annual diversions from Mallard Slough. And Mr. Alexander, Mr. McCarty, we did not put this into our presentation, because at this point in time, our only requirement -- preliminary costs are in the hands of our financial consultant. When such becomes available, I would be happy to submit it for the record.

Let's take a look at Mallard Slough within this westerly portion; dating back to 1926, you can see that we diverted water in quantities depending upon the outflow at any year.

If it's -- if the outflow is high, then we divert more water, but let's say that it's 1,000 acres per feet per year, which has certainly occurred.

Now, in the course of our negotiations of a replacement supply with the parts of water received, we arrived at an availability of 122 days. This is based on the figures that we were able to divert that high quality water, not exceeding 100 parts per million. We also determined by our own records that our costs to divert that by 3 million to a storage reservoir, was about $4,000.

We also know that other diversions upstream in processing through the city of Antioch particularly having a much lower cost in that they divert not more than 2,000 -- I've had figures in the area of about $1000 per acre foot. So, let's take an average of 3000 per acre foot for our discussion of it now.

Where our water costs now, by way of direct diversion from the river is about 490 or an average in the area of about $3, bearing in mind that our contract with the Department is for a ratio of only one third, the remainder, of course, has to be paid for by the District currently.

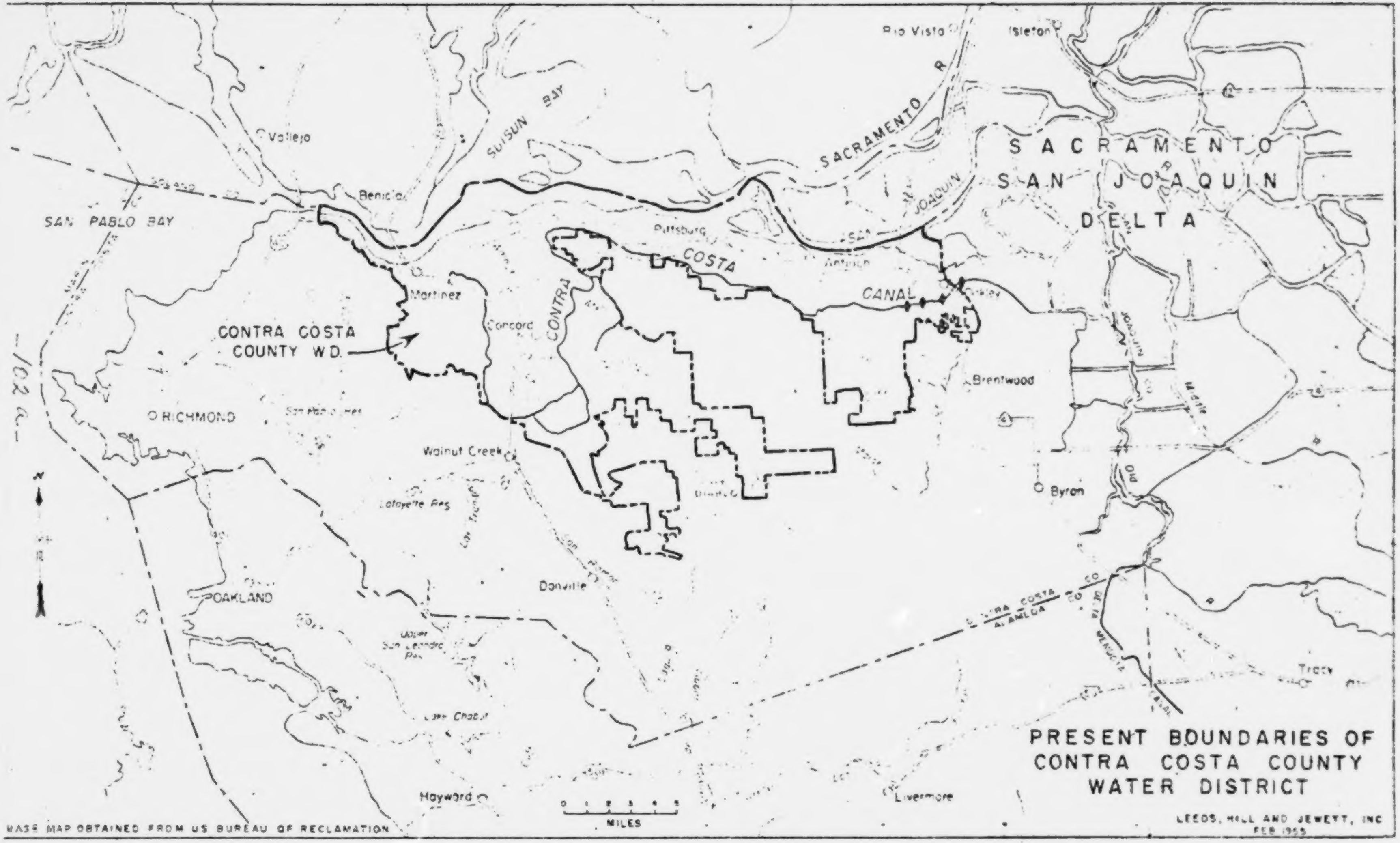
The replacement cost is three times that of the Department allowance. Let's say it another way, where we -- the average cost is $3. We have to pay the Bureau of Reclamation $10 an acre foot. Now, that's based on the water per acre of our rate of $10 per acre foot.

This year we exceeded the contract, and the rate is doubled, it's $20 a foot.

Now, our preliminary investigation shows that in the near future, the water cost of the Contra Costa Water District, based on a projection by the Bureau of both water supply and the many facilities, is going to be on the order of $36 an acre foot.

Now, on the basis of our current contract, the Department of Water Resources will allow us one third of what you can subtract, or $12 per acre foot, so our net cost will be $24 an acre foot, which is eight times more.

EXHIBIT A


Rio Vista
Isleton
SACRAMENTO R
SACRAMENTO
SAN JOAQUIN
DELTA
SUISUN BAY
Vallejo
Benicia
SAN PABLO BAY
Pittsburg
Antioch
CONTRA COSTA CANAL
JOAQUIN
Martinez
Concord
CONTRA COSTA COUNTY W.D.
Brentwood
Byron
Old
Middle
O RICHMOND
Walnut Creek
Lafayette Res
Danville
OAKLAND
Upper San Leandro Res
Lake Chabot
Hayward
Livermore
Tracy
CONTRA COSTA CO
ALAMEDA CO
DELTA MENDOTA CANAL
MILES
N

## PRESENT BOUNDARIES OF CONTRA COSTA COUNTY WATER DISTRICT

LEEDS, HILL AND JEWETT, INC
FEB 1955

BASE MAP OBTAINED FROM US BUREAU OF RECLAMATION

-102 a-

EXHIBIT B

## Historical Water Use From Contra Costa Canal

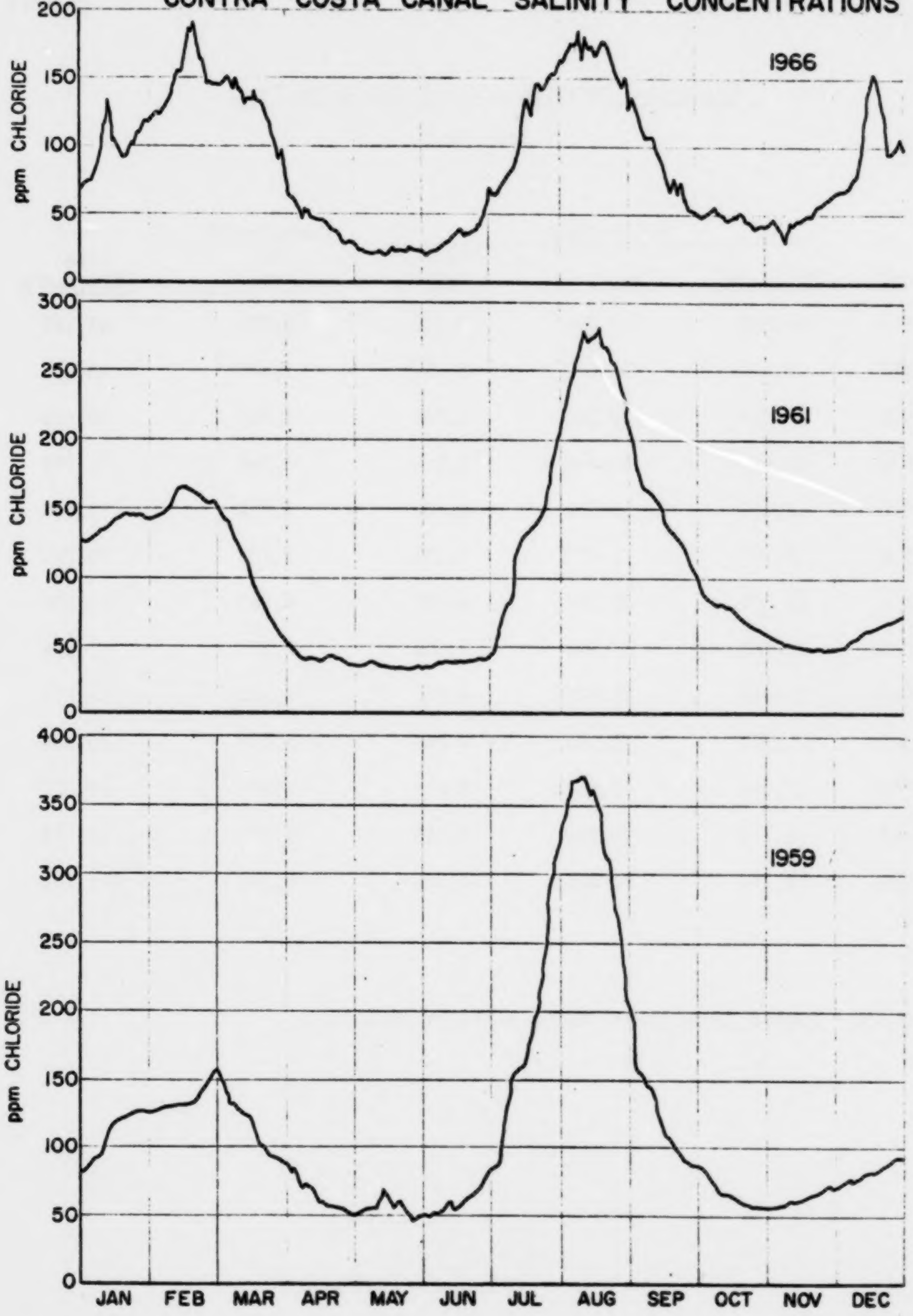
Acre Feet

| Year | Deliveries: Municipal | Deliveries: Industrial | Deliveries: Agricul-tural | Unaccounted-for Water | Total Diversions |
|---|---|---|---|---|---|
| 1956 | 16,681 | 19,716 | 5,057 | 3,728 | 45,182 |
| 1957 | 20,395 | 24,020 | 5,751 | 3,670 | 53,836 |
| 1958 | 17,410 | 25,609 | 3,744 | 3,700 | 50,463 |
| 1959 | 25,686 | 32,628 | 5,968 | 6,996 | 71,278 |
| 1960 | 24,200 | 39,832 | 5,309 | 7,712 | 77,053 |
| 1961 | 25,736 | 41,023 | 7,291 | 5,173 | 79,223 |
| 1962 | 21,855 | 32,974 | 6,687 | 4,560 | 66,076 |
| 1963 | 20,351 | 32,944 | 4,651 | 5,229 | 63,175 |
| 1964 | 31,274 | 43,050 | 6,737 | 5,513 | 86,574 |
| 1965 | 24,390 | 34,662 | 4,864 | 6,168 | 70,084 |
| 1966 | 32,916 | 42,831 | 5,867 | 6,703 | 88,317 |
| 1967 | 25,751 | 36,209 | 4,715 | 2,941 | 69,616 |
| 1968 | 38,714 | 50,896 | 5,385 | 6,193 | 101,188 |

Source: Contra Costa County Water District data.

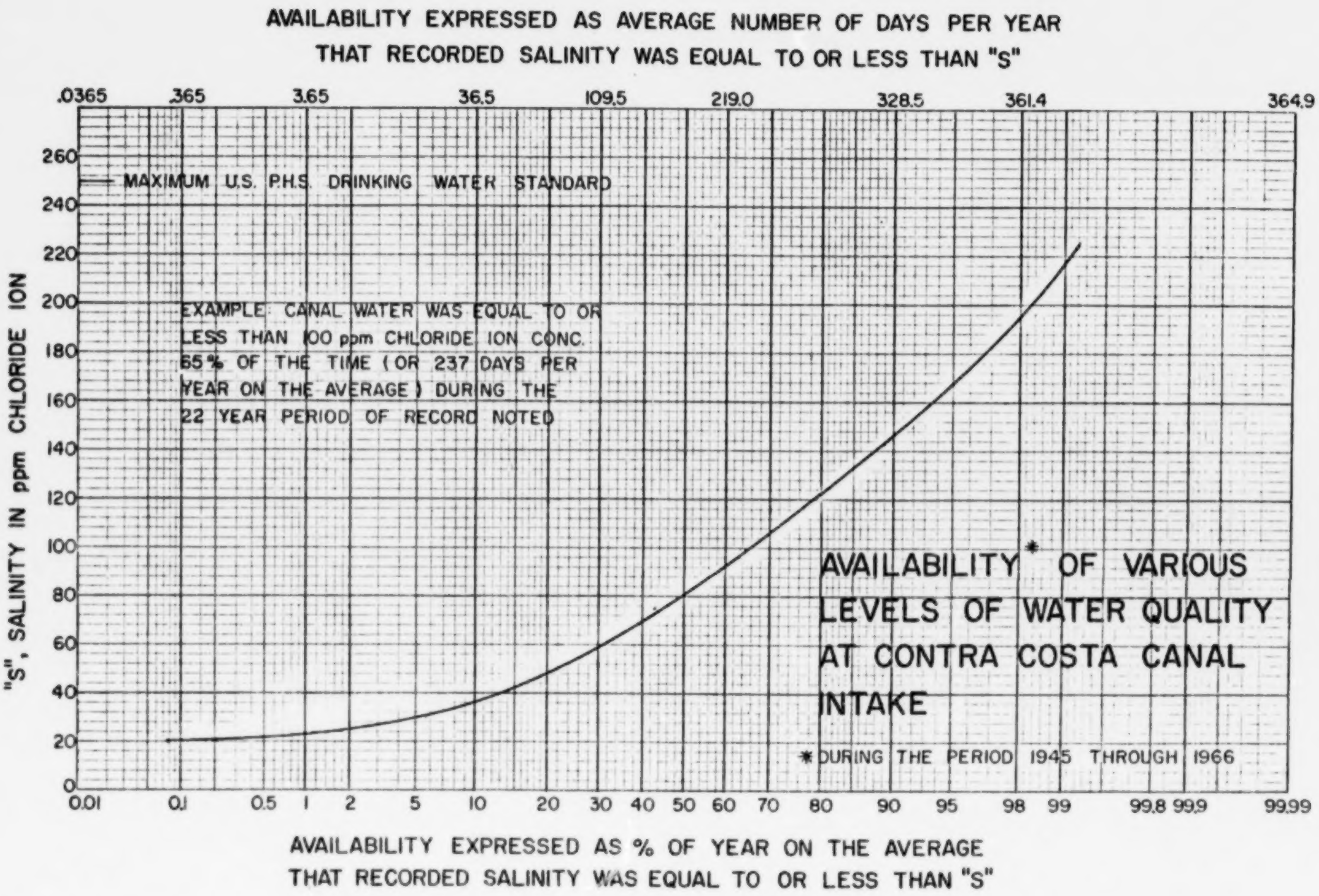
EXHIBIT C

# CONTRA COSTA CANAL SALINITY* CONCENTRATIONS



* PARTS PER MILLION CHLORIDE ION

EXHIBIT D



AVAILABILITY* OF VARIOUS LEVELS OF WATER QUALITY AT CONTRA COSTA CANAL INTAKE

* DURING THE PERIOD 1945 THROUGH 1966

EXAMPLE: CANAL WATER WAS EQUAL TO OR LESS THAN 100 ppm CHLORIDE ION CONC. 65% OF THE TIME (OR 237 DAYS PER YEAR ON THE AVERAGE) DURING THE 22 YEAR PERIOD OF RECORD NOTED

Exhibit E

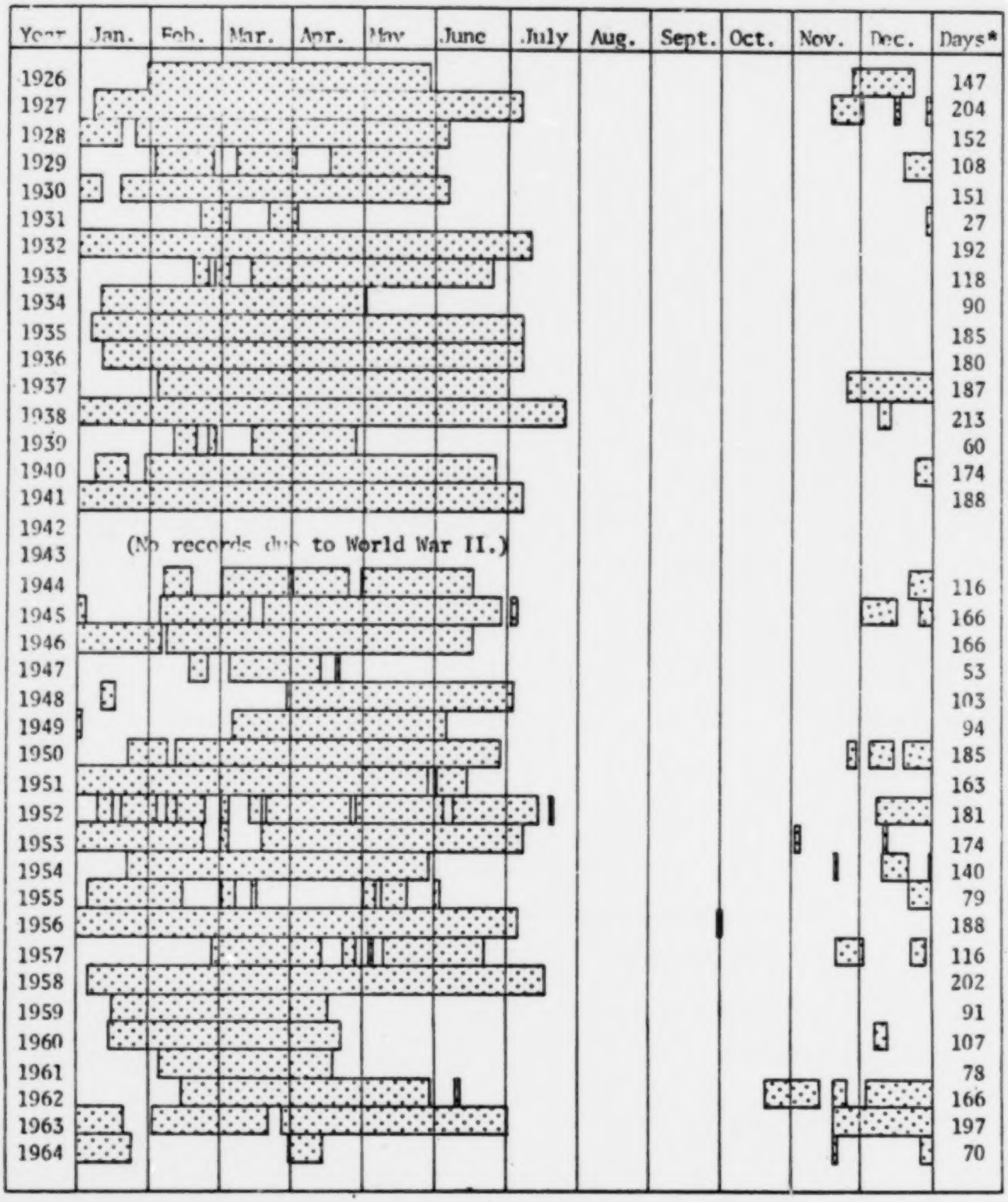
## HISTORIC ANNUAL DIVERSIONS FROM MALLARD SLOUGH

Acre Feet

| Year | Quantity Diverted |
|---|---|
| 1945 | 6,810 |
| 1946 | 8,280 |
| 1947 | 3,779 |
| 1948 | 5,490 |
| 1949 | 6,302 |
| 1950 | 7,350 |
| 1951 | 10,920 |
| 1952 | 10,595 |
| 1953 | 7,966 |
| 1954 | 6,567 |
| 1955 | 3,504 |
| 1956 | 7,138 |
| 1957 | 6,921 |
| 1958 | 7,486 |
| 1959 | 4,355 |
| 1960 | 3,349 |
| 1961 | 3,776 |
| 1962 | 9,106 |
| 1963 | 6,844 |
| 1964 | 2,788 |
| 1965 | 11,533 |
| 1966 | 1,881 |
| 1967 | 9,269 |
| 1968 | 5,384 |

Exhibit F

## Historic Availability of Good Quality* Tidal Water at Mallard Slough



* Water with choloride concentration ≦ 100 ppm as representative of mean tidal cycle conditions.

Exhibit G

## HISTORICAL WATER DIVERSIONS FROM SACRAMENTO-SAN JOAQUIN DELTA FOR USE WITHIN DISTRICT[a]

Acre Feet

| Year | Municipal and Industrial Process Water[b] (1) | Industrial Cooling Water[c] (2) | Total (Rounded) (3) |
|---|---|---|---|
| 1956 | 19,193 | 1,018,000 | 1,037,000 |
| 1957 | 20,652 | 1,184,000 | 1,205,000 |
| 1958 | 29,176 | 1,052,000 | 1,082,000 |
| 1959 | 22,575 | 1,143,000 | 1,166,000 |
| 1960 | 16,761 | 1,393,000 | 1,410,000 |
| 1961 | 22,026 | 1,569,000 | 1,591,000 |
| 1962 | 24,030 | 1,484,000 | 1,508,000 |
| 1963 | 26,135 | 1,423,000 | 1,449,000 |
| 1964 | 27,372 | 1,500,000[d] | 1,527,000 |
| 1965 | 38,813 | 1,500,000[d] | 1,539,000 |
| 1966 | 31,119[d] | 1,500,000[d] | 1,531,000 |

[a] Exclusive of deliveries from Contra Costa Canal.

[b] High-quality water.

[c] No quality limitations.

[d] Estimated.

Source: Contra Costa County Water District data.

Gentlemen, it has been a pleasure, and I am happy to appear here. If you have any questions, we'd be glad to answer.

MR. McCARTY: Thank you, Mr. DeVito. Do you have any questions?

MR. ALEXANDER: No, I don't believe I have any questions.

MR. McCARTY: Just one question, about your Exhibit B, Mr. DeVito. I notice you show a very significant increase in the total diversion in the past year. Is there any particular explanation for that? I also notice that you have a very low diversion rate for Mallard Slough on Exhibit D, because you had a dry cooling water year?

MR. DeVITO: Yes, Mr. McCarty. I think, if you look at the water correlation on Exhibit B as it moves up and down, is certainly consistent with the Exhibit F which shows historic availability at Mallard Slough.

By example, to your question, 1968, the District's total diversion at Rock Slough was 101,000 per acre feet simply because -- we call this a dry year. It also required more availability through the Contra Costa Canal System, and as you properly indicated, this shows a lesser pumping availability at Mallard Slough.

I think we can say it another way, that even though the average availability from the offshore is about 30 to 35 percent of high quality water, it varies from year to year; it is going to be considerably more from the offshore.

MR. McCARTY: Okay.

MR. ALEXANDER: I was wondering if -- is this Master Plan for Water Supply to be a part of the record?

MR. DeVITO: I would so ask, Mr. Alexander.

MR. ALEXANDER: Do you want that identified for the record?

MR. McCARTY: Yes. I should point out, the record is black and white, there are some colored figures in the back, if you would like -- still like to have that part of the record?

MR. DeVITO: We recognize that, Mr. McCarty; I think black and white will do justice to the report.

As a matter of record, I'll read the record in the transcript: Contra Costa Water District Master Plan for Water Supply, March 19, 1968, Leeds, Hill and Jewett, Incorporated, Consulting Engineers. Thank you.

MR. ALEXANDER: Very fine report.

MR. McCARTY: Our next speaker for this morning, I would like to call -- we have three more speakers -- perhaps we could take -- let's take a relatively short break, let's make it 20 minutes, and we'll be back to hear the final speakers.

(20-minute break)

MR. McCARTY: Gentlemen, we will begin our session again.

Our next speaker is Dr. Carl W. Chen, representing Water Resources Engineers, Incorporated.

Dr. Chen.

DR. CARL W. CHEN: My name is Carl Chen. I am an Associate Engineer with Water Resources Engineers, Inc., located in Walnut Creek, California. I would like to take this opportunity to express some thoughts about the emerging "systems approach" to the problems of water quality management for estuaries.

For the benefit of the audience, I would like first to define the terminology of "systems" and "system analysis approach"; second, to illustrate why we need the systems approach to help solve the water quality management problems of estuaries; and third, how the system approach can be applied.

A system is composed of many components that function individually and yet interdependently. For example, an estuary may be considered as a system composed of rivers, sloughs, mud flats, embayments, and a mouth serving as a connection with the open sea.

In this system, there exist various physical and chemical constituents which create an environment, as well as the biota that live in it. It may not be obvious, but it should be fairly clear that these components (and others not mentioned) are dependent on each other. Thus the tidal fluctuation at the mouth of the estuary affects the flow pattern of the whole estuary. The chemical constituents of water may affect the well-being of the biota and the biota may in turn modify the water quality constituents.

What is the systems approach then? The systems approach is simply an analytical procedure to identify components, to quantify reactions taking place in each component, and to take an integrated view of the overall phenomenon. It is used to tie each piece of information together to obtain a general comprehensive picture.

To illustrate why we need the approach, it is pertinent to cite some of the problems that need to be solved. For example, an estuary may serve many uses. Each use may need different quality requirements which may be complementary to one another or in conflict. The trade-offs and the accommodation of multiple uses to maximize economic benefits can be evaluated by systems analysis techniques called linear programming or dynamic programming. Just to give another example, many agencies have spent large sums of money collecting countless bits of data for tides, currents, weather conditions, physical and chemical qualities, plankton counts, and so forth. These data can be integrated and interpreted together by another systems analysis technique called simulation.

So much for the salesmanship for the system approach; how do we go about doing it? Simply stated, it requires a series of modeling activities. A hydrodynamic model must be developed first to simulate the movements of water under various conditions of tides and fresh water inflows. A water quality model can then be constructed to keep track of the transport of chemical constituents entering the estuarial system. An ecologic model follows to include and describe all the physical, chemical, and biological interactions. These three models may assist engineers to select water quality management alternatives that may meet all the specified or desired uses of our estuary. On top of these, an economic model may be created to find the optimal management alternatives in terms of least cost or maximum net benefits.

Water Resources Engineers, Inc. is a systems-oriented firm. Under the sponsorship of the FWPCA, the Department of Water Resources, and other state agencies, we have developed and applied hydrodynamic and water quality models for the San Francisco Bay-Delta estuary. Commissioned by the FWPCA, we have recently constructed an ecologic model. The ecologic model is still in its conceptual stage, but it will become operational in the near future. Our experience with the approach has been very encouraging. We recommend that the systems analysis approach be used in the contemplated comprehensive program for the preservation, study, use, and development of estuaries of the nation.

Thank you.

MR. McCARTY: Thank you, Dr. Chen. Do you have any questions?

MR. ALEXANDER: Yes. Dr. Chen, have you had the opportunity of using that model any place anywhere else except on the Delta here?

DR. CHEN: Yes.

MR. ALEXANDER: Where have you used it?

DR. CHEN: We used it in the Elk Grove Sloughs and we used it in the Pottsville Bay and I understand the FWPCA is using it in the Columbian River System.

The program has been designed so that you can take in various kinds of systems. You don't have to reconstruct the whole program, you just change the different conditions -- different regions, it's not as simple as such, though.

MR. ALEXANDER: No, I realize it's not that simple. Have you had an opportunity to make a pretty close check on all of the inputs by other systems of another type?

DR. CHEN: Well, the bigger piece of work to be done is for the San Francisco Bay-Delta system. We are currently using it for Elkhorn Slough.

Well, I was one of them looking about the input for the San Francisco Bay-Delta system. Now, we have another engineer using -- in the and he is looking very closely at what kind of input is getting into the system, and checking it out; and if they can be verified against the historical data.

MR. ALEXANDER: Have you attempted to verify it against the physical model at Sausalito?

DR. CHEN: We did, and they came out much better than what we thought.

MR. ALEXANDER: Has the physical model at Sausalito been extended upstream far enough so that it could cover all of your models?

DR. CHEN: They didn't as I understand, they tried to, but they used a different kind of bunkering condition. The main thing, it may not vary as much as it looks, as -- if you extend the Delta system incorporated into the model, but they are building it as I understand.

MR. ALEXANDER: They are still working on the experiment?

DR. CHEN: And, also they don't have the tidal change capability in their model which we do have, and also, they don't have the agricultural returnability, but they do have -- they have something -- something they have we don't, but once we point out that we should have it, we could incorporate it very easily.

MR. ALEXANDER: Thank you.

MR. McCARTY: One last question, Dr. Chen.

DR. CHEN: Yes.

MR. McCARTY: Regarding this system analysis approach, one of the things that we are interested in seeking, as a part of these public meetings, is an expression from people on ways of getting at the values of estuaries, either in monetary terms or aesthetic value, recreational values, personal values. Have you attempted or your firm attempted to look into these matters and try to come up with material?

DR. CHEN: I am currently working on a program called -- entitled "Life Evaluation," and that so-called evaluation should be called "Economic Evaluation," in which the major item is the recreational -- reclamation of wild rivers, and I have a feeling that once we get that ecological model built, which will form the basis, then on top of that, we will be able to build an economic model to take care of beneficial -- benefits which can be measured for beneficial uses.

Then, Dr. Macsono of our firm, he did a thesis on the subject, to deal with the tangible benefit problem. He uses some kind of plan based on the fact that this location is particularly unique; locally, regionally or state-wide, depending on this kind of uniqueness, that will be contained in this intangible benefit.

So, we are trying to develop methods at this time, we are not trying to say it's worth one dollar or five dollars.

MR. McCARTY: Thank you, Dr. Chen.

DR. CHEN: Thank you.

MR. McCARTY: Our next speaker this morning is Mr. Arthur L. Ogilvie, who is at present with the Santa Clara County Planning Department.

Mr. Ogilvie.

MR. ARTHUR L. OGILVIE: I have some slides here to show soon after I start to address you, and we haven't had a chance to adjust the projector, so I was wondering if we might do that at this time.

MR. McCARTY: Fine. Let me point out this one thing, I think I've mentioned it before, that everything in the transcript comes out black and white and --

MR. OGILVIE: These slides that we are showing can be reproduced, and we can furnish you black and white glosses if you like, glosses of this, which in many instances have this quality which in many instances will be very satisfactory for reproduction.

MR. McCARTY: If you would like those as a part of the transcript, we can arrange it.

MR. OGILVIE: Yes, I'd like to have that, and we'll be able to have these glosses to you before your trip.

All right, may we have the lights out, please.

Now, before we go into that portion of it, I'd like to give a brief history leading up to what we're going to be showing.

My name is Arthur L. Ogilvie, I'm a planner with the Planning Department, Santa Clara County.

A number of months ago, in our studies for review and amendment to our General Plan, we had a number of subcommittees that were looking at various aspects of our County; and three of these subcommittees were as follows: One was a Park-Recreation and Open Space Committee; another committee was the Committee for Bay Lands, and the third was an Agricultural Committee. Of course, I won't go into the other five committees because they're more or less standard in regard to planning for the County. In other words, covering houses, et cetera.

In our 1963 General Plan, the bay lands had certain land uses indicated, and the area of Alviso was indicated for a wildlife preserve. So, we're going to focus -- I'm going to focus this morning on that area in relation to the subject that this hearing is being held for, and that is in regard to pollution and water quality.

A couple of weeks ago, a San Francisco paper, the Sunday Section, produced a very nice map, and it tells quite a bit of the story about "Who Owns San Francisco Bay." There are some minor details, too, in the newspaper's presentation, it didn't produce quite as well as it could have been in relation to some of the estuaries and some of the creeks that are discharging into South San Francisco Bay. But, there is a definite relationship to the problem because of the ownerships.

To go back into history, in relation to Santa Clara County and South San Francisco Bay; about fifty years ago, which would make it around -- oh, nearly 1900, man in that area was mainly in the agricultural pursuit; and as a consequence, finally getting into the type of agriculture and so forth, to find enough water to be able to carry on, drilled wells for irrigation purposes, and of course, as the orchards flourished, man moved in in concentration, and communities developed, and along with the communities, more demands for water. And so, more wells were put down to serve the municipalities, and to serve then ancillary industry that was coming in to support this agricultural endeavor. I rather doubt that there was any real expert in the country that could visualize what this might cause, and as far as man's environment is concerned, because he was indiscriminate rather in drilling the wells and mine the water from the underground reservoirs.

It's only been in the last -- approximately 30 to 35 years that we have had the technology or the technology has been available to us, and to see what this has done to us.

And, of course, we have found, or I should say the Department of the Interior, U.S.G.S., has found that there's been a great subsidence in the northern portion of Santa Clara County, and it extends into Alameda County and Southern San Mateo County; and the reason for this, they state, is due to the mining of the underground waters; and they have indicated that through their surveys, that this subsidence is continuing.

And so, therefore, I would like to now show the slides, colored slides of their original work, and these maps -- we based this on available information from the U.S.G.S. Subsidence Office, the Federal Building in Sacramento; and the man that is in charge of this work is Mr. Poland.

So, may we have the first slide, please.

This shows the land subsidence in the three county areas that I was speaking of. The worst incident is in the San Jose area, and as you go out to the Bay in the Alviso area, for example, it shows approximately four feet (indicating). Now, this perhaps is not particularly alarming, but let's go back in history when they first started making records in regard to this.

U.S.G.S. had their maps showing the incidence starting in 1916. I believe it's to 1967, where it shows eight feet in downtown San Jose, the total from 1960 to '67 is nearly four feet. And, in the Alviso area, it's something like seven feet. And, they have also prepared a map -- another map, but to take your '34 to '67 map with a recent map, that we've come out with the '60 to '67 map, and it shows that this subsidence is accelerating.

In other words, from 1960 to '67, the amount of subsidence in the Alviso area has been nearly four feet of the seven feet, and likewise in downtown San Jose, approximately half of the whole in that brief span of years.

Now, how does this affect us? Well, I'm going to go on to another slide to show you graphically what this is doing to the area; and this is compounding in part the problems as far as your water pollution and so forth in the Bay.

MR. ALEXANDER: Before you move to the next slide, is your groundwater basin falling at about the same rate in -- since 1961-62?

MR. OGILVIE: In cases, don't quote me; there are other experts that you can get from the State or U.S.G.S., you can ask, but apparently there's definitely a relation.

MR. ALEXANDER: But, I was under the impression that since you put the reservoir in and replenishment, that you are able to stop quite a bit of this subsidence?

MR. OGILVIE: Well, I quote from Mr. Fuller, the Chief Engineer of the Santa Clara County Flood Control and Water District, and he states that they do not. See, any digressing in the subsidence rate before the year 1980, based on their statistics on their data --

MR. ALEXANDER: Is that because they'll be bringing in some more water and prevent the overdraft?

MR. OGILVIE: This is also true, and also there is a problem that is coming to the attention of many people that it will tend to be a particular -- at least I have been told this by some of their people that even though you percolate water to the south part of the County, this virtual dam does not permit it to get into the basin. You might say, we've got two basins. In the north county basin, where this is happening, is not receiving this water yet.

MR. ALEXANDER: Thank you.

MR. OGILVIE: May we have the next slide, please.

This is a slide taken of Alviso, and we're losing this definitely. (Indicating) So, you can relate visually, this building over on the right is the Alviso Yacht Club building, and you notice the people with their motorcycles and people there standing on old automobiles, upon the land there, and then you get down to this launch on the left (indicating), you walk down to the bank on the launch, and this is at high tide (indicating).

Next slide, please.

This was taken in October, in 1968; you walk out of the same building, and you walk upstairs way to the top of the dike, and there's the water (indicating).

So, here's your eight feet. Now, in BCDC's working on a page near the front of the book, just before you come to water-related industry, we have a map showing the subsidence, and with the written material in the report, they indicate -- their experts indicate that subsidence in this area, (indicating) they do not perceive any slowing down of the -- of water, along with underground -- from the underground basins, until there is seven more of the -- of subsidence here (indicating).

MR. ALEXANDER: Mr. Ogilvie, could you mention that page number and repeat the name of the report for the record?

MR. OGILVIE: They don't have the pages numbered, but this is the new San Francisco Bay Plan Report, which was addressed to the California Legislature, to the Governor, Ronald Reagan, and members of the California Legislature; and the cover letter inside is dated January 7, 1969.

MR. McCARTY: This is the report of the Bay Conservation and Development Commission to the Governor?

MR. OGILVIE: This is the report of the San Francisco Bay Conservation and Development Commission.

MR. McCARTY: Thank you.

MR. OGILVIE: May we have the next picture, please.

Now, going a little bit north to Alviso, the Station Island, which is in Coyote Creek; this is actually in Alameda County, and this is a little community in its heyday. It's called Drawbridge, and in its heyday, it was quite a place; and special trains came out of San Francisco, but particularly Oakland, for the society people of that day to come out here, and these were summer homes, second homes away from home (indicating), and they had their parties and their socials and they had weddings, and probably there was a little gambling going on and plenty of drinking. And, in the hunting seasons, there was plush hunting clubs; but due to subsidence, (indicating) you see this is the type -- this is how the buildings have degenerated where now they can barely be used any time. (Indicating) And, notice the white lines on the side of the buildings, that's your line of high tide. (Indicating)

Now, this building is unusable, so some of the people, to try to save their buildings, have gone out, torn them down, taken the material and rebuilt on stilts to try to have something that they can go out on weekends to get away from the urban crowds.

May we have the next picture, please.

This is the way some of those homes looked in their prior times (indicating) -- very plush. You notice, now, this building on the right (indicating), there up -- right -- there are two-by-fours where they've tried to raise their building above the effects of the tide. Now, this is nice salt marsh in this area.

May we have the next picture, please.

This will give you a little more detail of your putting them on stilts to get above high tide (indicating).

One of the hydrologists of the BCDC stated that in addition to the subsidence and high tide, we have a higher tide level here, (indicating) because the subsidence has caused the area to drop, and yet you go out into the Bay a little bit, and you've got a rim in here (indicating); in other words, the Bay comes in and then you've got a basin.

Now, in here (indicating), so that this creates a tidal water, so therefore, the water in the area is higher than it would have been if the area hadn't subsided.

Next picture, please.

This, I'm jumping to go to Mowry Slough in Alameda County, just a little bit north of the Station Island and Drawbridge, and this is a herd of harbor seals, that the Committee for South San Francisco Bay Lands Planning Conservation and Natural Wildlife Refuge discovered at the end of April of last year. I want to restate the fact that there is some improvement in South San Francisco Bay in the Bay pollution, and this is due, mainly, to the fact that we have sewage disposal plants, and we have these State agencies, and we also have controls at the local level.

This was an unpleasant accident -- thing to find, because the California Fish and Game people were not aware of this nursery--herd of 400 harbor seals in this area. And, one of the reasons that this herd is here, is because the food supply has improved. In other words, their food is fish. They're indiscriminate, probably, about what kind they eat, but this does indicate that -- we like to compare it, we're on the virtual knife's edge. Any more pollution right at this time, we can drop back the way we were 40 or 50 years ago.

Forty or fifty years ago along with the subsidence matter starting, we had the pollution -- concentration of pollution starting, because raw sewage was being dumped into the Bay, industrial waste was being dumped into the Bay and so forth.

So, the wildlife was dissipated. But, before the wildlife would leave the area entirely, its food supply was destroyed.

For example, at that time, the Bay received brief flocks of black brant which is a sea goose, small sea goose, and the reason that we do not have the black brant in the Bay, according to Bill Anderson in the California Fish and Game Department, who has been working with the committee, and who has been in contact with me, is due to the fact that eelgrass wasn't present in the Bay, it was destroyed through pollution. So, as a consequence, we have no black brant frequenting the Bay, except maybe an injured one, and it comes down to rest before it tries to join its brothers. Also, the fish were destroyed. Now, the fish are beginning to come back to some extent, for example, the Striped Bass are frequenting the South Bay; and the last two years, you've been catching White Sturgeon in the Bay for the first time in 50 years.

However, in the case of the estuaries, Coyote Creek, Alviso Slough, Guadelupe River, Mowrey Slough, none of those have Steelhead running any longer. There's a very small group of Steelhead along San Francisco Creek, which is the dividing line between Santa Clara County and San Mateo County.

We are hopeful, with the continuation of sewage pollution controls and tightening on them where need be, that some of these wildlife species can be reintroduced into the area. And, this is an indication, right here, with the harbor seals that the wildlife can come back to some extent.

Now, there are some species that will never get back.

So that you can see what one of these harbor seals looks like, we have a glossy picture here; I'll pass these around, and I'd like to clarify the fact that many people miss -- it's a misnomer to call them seals in circuses and so forth, because they're not, they're usually female sea lions, young sea lions, and the difference between these and these harbor seals is that they are a different species, and the reason that they frequent places like this where there's food, and the most part, the shores are rather flat, and because of the construction of their flippers; and they do not have the jointed flippers that the sea lion has. So, therefore, all these areas where they are, their fall playground, and all they have -- their flippers and they draw themselves out onto this plush land and into grassy areas; so this is a kind of habitat that is almost a must, first from the fish, and secondly, because of the type of shoreline that we have.

Now, may we have the next slide, please.

Now, in this area also, we have a habitat that is very unique, and this is a rare California Clapper Rail, and this is the type of habitat that it frequents and where it mates. It's a salt marsh area, there is cordgrass for it; and I'm going to refer to cordgrass in relation to silting and sedimentation. The Board has just included it in rare specimens, in the Department of the Interior's Red Book of Rare and Endangered Species. The next step is to make it undangered, and we'll have this some time next year. The new book is coming out by the Department of the Interior, it will be included in it, it has lost almost all the power of flight in evolution, so this habitat is a must for it, and any encroachment on this habitat will cause it to become extinct along the Bay.

Next slide, please.

These are black-neck stilts, and you notice that they are wading in a very shallow -- right next to the mudflats.

Next picture, please.

These are marble gotletts. All these pictures, mind you, have been taken in the South Bay Area. What people don't realize is that when you dredge the Bay to deepen the water, that you're destroying the habitat needed by the shore and wading birds. These birds here are waiting for the tide to go out so that the mudflat is available for them for their feeding area. So, in dredging, it's fine, it does supply water surface which helps in part to maintain our climate, but you've destroyed the wildlife habitat area by doing so, and you've also destroyed the habitat where the food for birds, fish, molluscs, and mammals originate. And, fortunately, the Department of the Interior had been instructed under the Congressional bill, what we call -- sometimes call the Dingwell Bill, studying the estuaries of the country, and that study is due back on the President's desk on January 12, 1970. We hope that that will point out a lot more of the real values of ecology and ecological system, and the need for preserving these resources.

Turn it off now, please.

Now, I would like to state, briefly, going inland somewhat where our silting and sedimentation originates; there is a new film that has just been developed by the Department of Agriculture, "Using Self-Preservation Called Mud." That's the name of it, and it deals with silting and sedimentation. I have not had an opportunity as yet to see the picture, but we have it on order for our Department so we can view it. But, the people that have reviewed the film say it's absolutely shocking and frightening. And, the reason that we have great amounts of silting and sedimentation is because we have machines flattening the hills and grading operations and so forth. And so, we have a rain, and the next thing that ends up is a trickle, and the next thing it goes to the sources -- it goes down to the water sources, and there it goes to the creek, it crosses from there to the estuary, and ends up in the Bay. Then, we turn around, and for example, like at Palo Alto Harbor; now the County is contracting for dredging so that we can use that for recreational purposes, and they're going to have to dredge that mud up at great expense to the taxpayers.

Now, because BCDC and we in our Department are quite in accord that this mud not be taken out by barges and dumped in the Bay like it has in the past, we ask that they find a place that is satisfactory for BCDC to be disposed of; so we're working it out with the Public Works Department, and conferring with other agencies to find suitable places to dispose of this.

But, I'm pointing out the fact that man in his rush of development and his rush to make money, does not take into consideration the whole ecological system and what effects it can have economically to him in the long run. So, as far as back in the watersheds, and this is going to have to be studied, it's going to have to be examined, and various agencies, jurisdictions, local governments are going to have to be cooperating and working closely together to study this and come up with rules and regulations that we can slow this down.

I had the question raised to me in Alameda County in regards to this subsidence, I'm jumping around a little bit, but this is such a tremendous subject, that I don't have the time to cover all aspects; this subject could cover days, but I would like to bring in bits and pieces that do have a bearing and interrelate. I had the question asked of me in regards to subsidence, "Why is it that certain parts of the Bay, that the subsidence is not noticeable, that the mudflats and the marsh areas are relatively the same elevation they were before the subsidence began?" And I had this backing on this conceived from hydraulic engineers, and so forth, naturally I do have their professional advice; but what happens is that this silt and sedimentation is coming down our streams, plus they do give us problems. Where we have recreation, it has a tendency to fill those streams, and because of the discharge is not once what it was, and that's mainly due to reservoirs and dams upstream, but the water that does get through with this silt and sedimentation, quite often comes in contact with the mud shores, and particularly with the marsh grasses; and the marsh grasses help greatly to screen out the silt and sedimentation, and they drop in the grasses.

So, nature is doing a better job in this respect than man, and it's helping to clear up a great portion of the Bay, and also the turgidity, to the point where the Bay can be more effective in producing oxygen which helps man's environment, and helps clean up the pollution.

The little animals, fish, molluscs, and what have you that frequent and live in this area are great producers, and in turn are great cleaner-uppers, if I can put it that way, of the water. For example, myriad millions of mud snails help, they are filter feeders, and they help to clean up the pollution and help clean our water.

What I'm getting at is this: That we need to do many studies in relation to this, and I think that it's high time that we took a very close and hard look at it, because our children, those that are in school now and in college are suddenly going to swarm in on us and accuse us of being traitors to our country, because we haven't done a better job. And, I'd hate to mention why I made that statement as I do. In this State, this last year, part of the education of legislature has passed legislation whereby it's mandatory to teach nature in the public schools, providing the school has the funds and staff to do so.

Santa Clara County started this program in the sixth grade three years ago, and presently have 19,000 students in it. In addition to this being taught in classrooms, they have a summer camp -- not a summer camp but have a nature camp where they take these students with the teachers, for a solid two weeks to teach them.

Just the other day, San Jose State College's representative was out before a group of the public, in connection with a purchase at now is in back of Los Angeles, and it was the property of a Catholic School, but due to difficulty, they closed it, and San Jose State wants to purchase that property to establish a school of environmental studies with a student body of 980 students to begin with, eventually 1200 students. It will be a 4-year course of study. They'll have their professors, their instructors will be there, and they'll have very little interchange with the parent school in downtown San Jose.

I feel that these people are going to call us to task if we do not -- eventually they are going to call us to task if we don't start doing a better job.

One of the things I'd like to point out, in connection with this, I think it's absolutely mandatory that we do everything in our power to find the monies to start the studies.

Now, in regard to ecological or environmental aspects, particularly in relation to the old concept of cost benefits; it's far antiquated and outdated, and it's time we relate this to our environment and if the ultimate cost -- the cost to the public for many of these things that we do on short-term basis, and on that note, I would like to thank you people and if there are questions, I'd be happy to answer your questions.

MR. ALEXANDER: We might have one question or two before you leave, Mr. Ogilvie.

MR. OGILVIE: Well, I'll be here.

MR. ALEXANDER: We will be up there at the meeting so we can hear you.

MR. McCARTY: Go ahead.

MR. ALEXANDER: I take it from your testimony, Mr. Ogilvie, that you feel that the water quality problem is improving in the North Bay to a certain degree?

MR. OGILVIE: I would say, perhaps North Bay. I can't speak specifically for the North Bay, but I surely can for the South Bay, having worked closely with the habitat areas for the last several years.

MR. ALEXANDER: Well, I may have misquoted myself, but you feel that it's improving in that particular area?

MR. OGILVIE: Yes, but I -- in talking with people about this, I say that we must not let down; we must forge ahead, and we must be very vigilant to see that that does not regress.

MR. ALEXANDER: The other thought that comes to mind, with this subsidence, are you having more of these salt marshes, is it making more salt marshes and expanding the area over what it would have been without the subsidence?

MR. OGILVIE: It's very difficult to tell on that basis; I would say that it's possible. Of course, with the salt ponds, the diking facilities for salt ponds and so forth and other man developments around the fringe of the Bay, and looking at the area's salt ponds; they remove great vast areas of marsh. So, I can't really equate an answer to your question. It needs further study.

MR. ALEXANDER: One important question I don't think you've touched on, is who do you feel should be the one that should manage these estuaries, and how should that be set up? You're coming into a management program.

MR. OGILVIE: Well, I can only speak for our Department, I can't speak for our Commission or Board of Supervisors, but many of us in our Department tend to feel that we need a form of regional government, somewhat like the BCDC would be helpful, or one that would be somewhat similar to replace it.

Now, in relation to the area of Alviso, in regard to that, having been shown previously, in the past year or so, wildlife reserves, we look to the National Government, the Bureau of Fish and Wildlife to do that; so we feel that perhaps between the State and the Federal Government, perhaps a consortium.

Now, this is my own opinion, between the State and Federal Government, a consortium could be worked out, working with local government and a system working together to do this.

MR. ALEXANDER: Thank you very much.

MR. McCARTY: One last question, Mr. Ogilvie: Since you are with the Planning Commission --

MR. OGILVIE: Planning Department.

MR. McCARTY: Planning Department, I'm sorry. Is your Department looking forward, in the future, to any swimming areas anywhere in the South Bay of Santa Clara County that comes in contact with Bay waters?

MR. OGILVIE: We're conducting a study in our Department under an urban assistance grant, our people call it a 701 Grant, for parks, recreation and open space for the entire County, and at the present we're doing -- working with the cities; we're gathering data and information in regard to this, and studies -- what we have existing, what the needs are for the future; and so, we're looking at all these aspects, and it is not inconceivable that perhaps it's to be done.

This could be done now, that area immediately available to Alviso, it's an old subdivision, a paper subdivision, where the people purchased lots, and it reverted to the County and City because of nonpayment of taxes. They conceive of putting a park and recreation in there, and perhaps a small wildlife preserve. It's not very far from now; a County marina in Alviso, and it's very possible that something like this could be worked out. I can't say at the moment; we have not -- our report will not be due for another -- well, our time runs out toward the middle of this coming year, 1969, and we're going to have to put in another year for study and ask for another grant for another year.

MR. McCARTY: Thank you, Mr. Ogilvie.

MR. OGILVIE: Thank you.

MR. McCARTY: I would like to call on our next speaker, Mr. Hanford Eldh, who represents the Santa Clara County Fish and Game Commission, he's the Chairman of that Commission.

MR. HANFORD ELDH: My name is Hanford Eldh, I'm Chairman of the Santa Clara County Fish and Game Commission.

This meeting was unbeknownst to me until early this morning. Mr. Ogilvie called me, so I'm not prepared to speak for the County Fish and Game Commission; not having had the time to clear it with the rest of the Commission. Any comments today would be strictly as an individual citizen, as an individual.

Apparently there were some comments made yesterday about the pollution condition in our area in the South San Francisco Bay, in the Alviso area. I'm not prepared to speak on it as some of the former speakers here, but I would like to make a few comments in regard to a rather -- pretty much by accident, a firsthand report I had on water pollution, was a call from a friend on the Police Department who informed me that "there's a green and red chemical finding its way into the Guadalupe River."

And so, on a Friday evening, on January the 10th, it had rained off and on during the day and rather cloudy; but I did run out to see it, and I did take a sample. The creek, at the bridge, at the Guadalupe Expressway, an Airport Boulevard, where the stones were dumped into the creek, was like a green carpet across the stream, and looking down the stream toward Alviso just as far as you could see, it was as green as it could be. The water above us was just the normal color of the creek, a little muddy, but not too bad.

I tried to contact -- I did contact the Fish and Game in the area, and he was headed for San Francisco for a meeting of all the State Fish and Game personnel, and so Saturday morning he did come over and we went out to take a look at it, but the plant before this apparently wasn't operating and it had rained; and we decided to take it out -- to ride out to Deacon's Landing, it was the last weekend of duck season, but what we had in mind was pollution, had come up rather suddenly; and there was a truck parked, it was one of the trucks contracted to pump out septic tanks. And, we watched them finishing unloading his load.

As he started driving away, we stopped him and talked with him and asked him what he was doing and what he was dumping and who he was with, and it turned out to be a contractor from the Bay of South San Francisco, and he had customers, he said, all up and down the Bay, and the stuff he had dumped in the Bay there in the area, he dumped right into running water, right into the Bay, and he said it came from a laundry in San Jose. So, we doubled back to this laundry and talked with the employer there, they confirmed that this contractor had picked up a load approximately an hour earlier, and we questioned them whether or not the City Health Department had ever checked them. He said, "yes," they're in there quite frequently, every month, and every week, sometimes oftener. They had been in there just a few days prior to this.

And, from further questioning, we developed that the inspector -- Health Inspector advised them whether they were allowed to pump into a sanitary sewer or not. We asked them what became of the stuff they were not allowed to pump into the sanitary sewer, and he stated that we pay a contractor X number of dollars a month to haul it out.

MR. McCARTY: Where does he put it?

MR. ELDH: You tell me.

MR. ALEXANDER: Now, you caught him dumping this?

MR. ELDH: Yes. We did take a sample of what -- the solids and the liquids, and we have that. And, Monday morning we checked with the City Public Works Department, and they referred me to the people at the disposal plant. They called me, they're aware that this septic tank contractor had been operating in the area, but had never been able to catch him they claimed, but it seemed to be quite impossible to get any direct answers from who operates the dumping, under what regulations, what they're allowed to accept there. We did find the samples that we originally picked up at the bridge, at the Guadalupe Creek, contained -- well, I don't have the information with me, but I remember one of them was cyanide, 2.4, and .05 was fatal to fish life.

MR. ALEXANDER: Mr. Eldh, aren't these septic tank contractors that are cleaning those out and hauling these chemicals and other things, aren't they licensed under your County ordinances?

MR. ELDH: They're licensed, they have a city business license is the only thing I've been able to find out, and I met with the septic tank contractors, and they're -- some are legitimate fellows, and they called a meeting and I requested them, at this meeting, as to what arrangements they had with the City or the County to dump the stuff they haul out in the tanks, and they haven't been able to make any arrangements with the City. And, I asked them if there was any way of knowing any -- can they estimate the number of gallons they pump out of the tanks per day; and after mumbling back and forth, the few at the meeting, they decided a minimum of 30,000 gallons a day.

So, I asked them what percent of those gallons would find its way to the Bay; and the answer was every gallon of it. There's no place to go.

And, I also talked to the Mayor a week ago yesterday, and asked him if he was aware of the number of septic tanks in the Bay Area, and he said, "no," he had no idea. I asked him what happened to the material that was pumped out of the tanks; he never gave it a thought. But, there are septic tank contractors who are very cooperative, they know it's wrong, they know it's a bad thing to do but they have no choice. They can't do anything with the city, and they dump, privately operated contractors dump -- five to seven dollars a load -- and the dump operators tell them where to dump, and I don't know; I spent a day with a dumper, and I was with him when he uncovered stuff, pumped 1400 gallons onto his truck, rode with him to the dump and the dump operator instructed him where to dump it. He opened a valve and emptied the tank and it ran right into the Bay there.

MR. ALEXANDER: Have you contacted Mr. Dierker who is the Regional Quality Officer in this area?

MR. ELDH: No, I heard about him today. I could have been better prepared if I had been aware of the meeting.

MR. ALEXANDER: Well, I would recommend that you do get in touch with him, and I think probably -- I've talked to Mr. Gribkoff, and he will have him get in touch with you.

I think there are County ordinances as to what -- who can be licensed, if they are not handling it correctly.

MR. ELDH: Well, the contractors want to cooperate, they will put up -- they'll put up a place to dump it legally, they realize it, they only -- it's the only place where you can dump.

MR. ALEXANDER: Well, we'll certainly get in touch with the Board.

MR. ELDH: I'll be glad to discuss it further with anyone who is interested in this.

MR. ALEXANDER: Well, we appreciate the information, we certainly will get to the right party -- get to the bottom of things.

MR. ELDH: With the Department of Fish and Game's going down taking samples, we found where these chemicals were coming out of industrial plants, that five gallons, that five gallons from the dump truck into the stream, and the five gallons that go further upstream. I have that information and I feel that we should have a complete report on it, it's due now.

MR. ALEXANDER: Well, thank you.

MR. McCARTY: Thank you, Mr. Eldh.

Is there anyone else in the audience who would like to make a statement at this time for the record?

MR. ALEXANDER: I would like to introduce Mr. Kerry Mulligan, Chairman of the State Water Resources Control Board.

MR. McCARTY: Do you have a final closing remark?

MR. KERRY W. MULLIGAN: No, I'm just visiting.

MR. McCARTY: I would like to repeat, again, that the record will be held open until March 14 for any additional statements that you would like to make. The transcript should be available within about three months from this date.

I want to thank again all of the participants who participated here today and yesterday, and those in the audience.

I, personally, have gained a large amount of new knowledge as a result of these public meetings, and a better insight in the State of California's unique problem with estuaries.

I particularly want to thank the State of California, not only for putting on this meeting, but for the assistance they provided in providing State-produced films on the activity of estuaries in the State of California, and for their official views on what the management programs will be.

I think with this I will call the meeting adjourned.

MR. ALEXANDER: It has been a real pleasure working with you, Mr. McCarty, and I want to assure you that the State Water Control Board will continue to operate in the highest manner they can in regard to the work they are doing.

MR. McCARTY: Thank you, I appreciate your assisting us. The meeting is adjourned.

JEROME R. WALDIE
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March 10, 1969

AIRMAIL - SPECIAL DELIVERY

Mr. Paul DeFalco
Regional Director
Pacific Southwest Region
Federal Water Pollution Control Administration
760 Market Street
San Francisco, California 94102

Attn: Mr. James C. McCarty, Jr.,
FWPCA Regional Estuarine Program Coordinator

Dear Mr. DeFalco:

I herewith submit additional material to augment my oral statement of February 19th, 1969, in San Francisco at the public hearings on Estuarine Management.

I should like to add the enclosed article, "Effects of Dedreased River Flow on Estuarine Ecology," by Professor B. J. Copeland of the University of Texas. I believe that Dr. Copeland's findings are most significant in light of the possible adverse effect of the proposals of the State Water Plan to divert a great amount of the fresh water inflows to the San Francisco Bay - Delta Estuary System.

I again would like to express my appreciation for your courtesies during the February hearings.

Sincerely yours,

Jerry Waldie
JEROME R. WALDIE
United States Congressman
Fourteenth District

JRW:mrr
Enc.

# EFFECTS OF DECREASED RIVER FLOW ON ESTUARINE ECOLOGY

*B. J. Copeland*

With rapidly expanding industrialization along the waterways of the world, water usage has become a legal and economic problem. The phenomenon of low flow occurs naturally in times of drought and many studies during drought conditions have shown that the effects of reduced river flow are diverse and far-reaching. The practice of decreasing river flow by the installation of reservoirs is frequently followed without consideration or prior knowledge of the effects downstream, particularly in estuaries.

Estuaries are important in many ways. Many important commercial and sport fishes and invertebrates use estuaries during some stage of their development. Estuaries probably are the greatest producing areas accessible to man for available protein. Many people use these waters for recreation, and industry uses them as factory sites because water is available for transportation, processing, and waste disposal.

As used in this paper, the word "estuary" means a body of water between the mouth of a river and the sea. Since lagoons are really "old estuaries," the term estuary, as used here, includes lagoons, bays, and sounds.

## Currents and Hydrography

An intricate current system within estuaries is produced by the balance of river discharge and the contribution of the sea. With decreased river flow, the current system can be so altered that shoaling and scouring can set up completely foreign physical conditions.

The most important hydrobiological parameter is salinity. Under normal conditions, salinity is variable in some estuaries. Collier and Hedgpeth (1) showed a direct correlation between river flow and estuarine salinity in Corpus Christi Bay, Texas. If river flow is restricted by upstream reservoirs, the salinity level in the receiving estuary may increase to the detriment of estuarine biological communities.

Closely connected to river flow is the maintenance of natural inlets between barrier islands, connecting estuaries to the sea. Simmons and Hoese (2) suggested the necessity of river flow for maintaining discharge through Cedar Bayou, a natural inlet on the Central Texas coast. Lack of river flow during the early 1950's resulted in the closing of Cedar Bayou. Passes can be kept open only at great expense if river flow is reduced below the level required to maintain them. The passes are important passageways for fish and invertebrates between nursery grounds and feeding areas (2) (3) (4) (5) (6) (7).

## Oyster Production

Oysters flourish in a wide range of salinity, and the production of oysters is exclusively estuarine. Oyster production in 1962 amounted to about $16,000,000 in Chesapeake Bay and $6,000,000 on the Gulf Coast. Production by weight was about the same, however, amounting to $20 \times 10^6$ and

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*B. J. Copeland is Assistant Professor, The University of Texas, Institute of Marine Science, Port Aransas, Texas.*

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$19 \times 10^6$ lb ($8.6 \times 10^6$ and $9.1 \times 10^6$ kg) respectively (8).

Under normal estuarine conditions, occasional flushing with fresh water from rivers helps rid oyster populations of damaging parasites and eliminates species that compete with oysters for food (9) (10). With reduced river flow, however, salinities may remain near or above that of seawater with the result that damaging parasites and competing species thrive.

Wells (11) reported a decrease in number of species of oyster parasites and scavengers in the Beaufort, N. C., area as salinity decreased. The abundance of boring sponges, major oyster parasites, decreases as salinity decreases (12) (13) (14). Most of the boring sponges in the high salinity areas of Newport River, N. C., were killed when the salinity was lowered during heavy flooding of the river (14).

*Dermocystidium marinum,* a parasitic fungus, is often a serious threat to oyster populations and may be controlled by dilution with fresh water (15) (16) (17) (18) (19) (20) (21) and (many others). *D. marinum* is common on oysters in moderate salinities, nearly always absent in salinities below 10–15 ppt, and only occasionally found in salinities approaching 35 ppt (18). Although the average salinities may be similar in various estuaries, areas with the greatest fluctuation in freshwater inflow (salinity fluctuation) have the least *D. marinum* infestation. A sudden drop in salinity as a result of flooding with fresh water may be enough to check the fungal growth. Apparently it is necessary that freshwater inflow occur in spring to check the infestation effectively.

Another widespread and destructive oyster parasite is the oyster drill, *Thais haemastoma,* which also is sensitive to salinity changes and is usually eliminated by moderate to low salinities (22). The Atlantic oyster drills, *Urosalpinx* and *Eupleura,* are sometimes quite destructive to oysters (23). They, too, are controlled in moderate to low salinities and/or with periodic flushing with fresh water.

Franklin (24), in a well-documented newspaper article, discussed the new, yet unnamed, oyster disease MSX. Apparently, MSX is limited to waters with over 15 to 20 ppt salinity, thus controlled by freshwater contributions.

In spite of the tremendous need for fresh water by the oyster industry, an over abundance will upset the balance. Andrews *et al.* (25) reported oyster kills when the salinity was lowered in the James River, Va. Butler (26) and Gunter (27) reported oyster kills over large areas of the Mississippi Sound during floods of fresh water. However, if flooding occurs for only a short period, oysters are capable of remaining closed for several days and avoiding the harmful effects.

Galtsoff (10) discussed the decrease in the oyster population of Texas bays during the drought of the 1950's. He suggested that the resulting increase in salinity in coastal waters during that time allowed the influx of parasites and diseases and the higher salinities (above 40 ppt) restricted gonad development. Surveys by the Texas Parks and Wildlife Department (28) (29) indicate little or no oyster harvest in Texas bays that receive little fresh water.

## Shrimp

Commercially important shrimp (Peneidae) are spawned offshore and the young migrate into estuarine nursery grounds, generally as postlarvae, to complete the life cycle. There, utilizing the higher productivity and abundant dissolved organic material, they grow rapidly, sometimes more than one millimeter per day. Along the Gulf coast shrimp is the most valuable of all fishery products, amounting to more than $60 million in 1962 (8).

The entrance of postlarval penaeid

shrimp through the Aransas Pass Inlet, Texas, corresponds to high flow of the rivers of the area in spring and fall (Figure 1) (30). Undoubtedly, this coupling of peak migration and increased river flow (accomplished through years of natural selection) is essential for the propagation of penaied shrimp.

Important fluxes occur in estuarine ecosystems during the high flows of spring and fall, including flows of vitamins and other dissolved organic compounds, nutrients, lowered salinity by the addition of fresh water, and flushing and mixing influences. Burkholder and Burkholder (31) reported a greater concentration of vitamin $B_{12}$ in the mud and estuarine waters of Georgia than in the adjacent seawater. Starr and Sanders (32) found similar results in other areas, and postulated that productivity of the nearshore sea was greatly dependent on suspended solids brought into the estuary by river flow. In attempts at raising shrimp from the egg to juvenile stage in laboratory experiments, it was found that it was necessary to add vitamin $B_{12}$ to the seawater aquarium, according to a personal communication from the Bureau of Commercial Fisheries, Galveston, Texas.

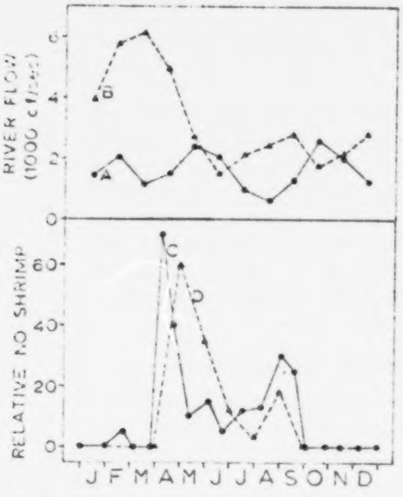

**FIGURE 1.—Relative number of postlarval penaeid shrimp entering the bays, and river flow of coastal rivers. A. River flow for Guadalupe River near Victoria, Tex.; 10-yr avg 1953–1962; B. River flow for Neuse River, near Kingston, N. C.; 10-yr avg 1955–1964; C. postlarval *Penaeus aztecus* and *P. duorarum* entering Texas bays through the Aransas Pass Inlet (30); D. postlarval *P. aztecus* and *P. duorarum* entering the Brunswick-Onslow bay area of North Carolina (59).**

Gunter (33) found that postlarval penaeid shrimp were most abundant in waters of moderate salinities, although other features were the same. At least 2 species of *Penaeus* are hypoosmotic to seawater and hyperosmotic to low-salinity waters, with isotonicity occurring between 25 and 30 ppt (34). At lowered temperatures, however, the ability to regulate osmosis is slightly impaired, which may account for movement to deeper (and more saline) waters.

Gunter and Hildebrand (35) showed a correlation between catch of white shrimp on the Texas coast and average rainfall for the state. Their correlation coefficients were significant to the one-percent level when rainfall of the two previous years was correlated with an annual catch. This method of analysis was considered valid since the reproductive cycle of shrimp is one year or more, large bodies of water change their salinity slowly, and dry land absorbs more water (less runoff) following droughts.

A plot of shrimp catch and average rainfall for Texas is shown in Figure 2. An increase or decrease in rainfall is followed by similar fluctuations in shrimp catch, generally after a two-year period. After the drought during the early 1950's, white shrimp populations never fully recovered, in spite of technological advances and increased fishing effort. Presumably, the addition of several reservoirs in Texas during this time prevented river runoff from approaching the level of previous years.

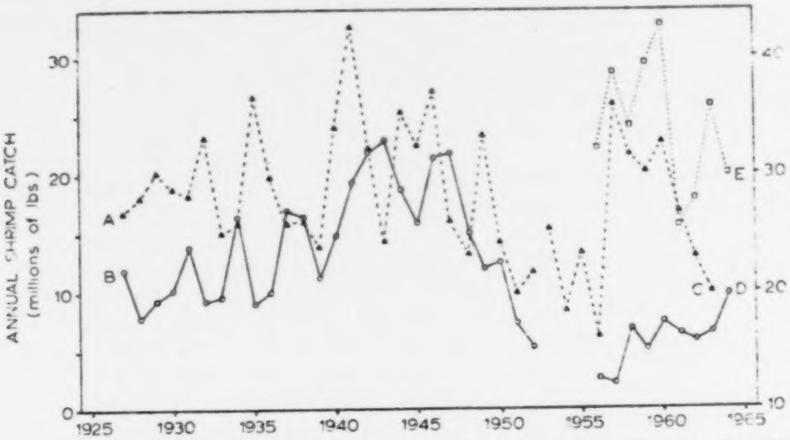

**FIGURE 2.**—Annual shrimp catch and average rainfall for Texas, 1927–1964. A. Avg rainfall for Texas, 1927–1952 (35); B. annual catch of white shrimp (*Penaeus setiferus*) from Texas waters, 1927–1952 (35); C. avg rainfall for Texas, 1953–1964 (U. S. Weather Bureau, Climatological Data, Annual Summary, Vol. 58–70): D. Annual catch of white shrimp (*P. setiferus*) from Texas waters, 1956–1964 (from U. S. Bureau of Commercial Fisheries, Gulf Coast Landings, 1956–1964). E. annual catch of brown shrimp (*P. aztecus*) from Texas waters, 1956–1964 (from U. S. Bureau of Commercial Fisheries, Gulf Coast Landings, 1956–1964).

Gunter (36) reported a general decline of white shrimp along the Texas coast and suggested that it be attributed to the drought. He further postulated that the appearance of larger white shrimp populations in Galveston Bay and smaller populations in the bays to the south be attributed to the decrease in freshwater contribution to Texas bays in a southerly direction.

### Blue Crab

The blue crab (*Callinectes* sp.) fisheries ranked sixth in value in the United States, with a value of $1.5 million on the Gulf coast in 1962 (8). The life cycle of blue crabs is closely connected to estuaries, and estuarine ecology is a vital factor in the maintenance of a continuous crab fishery.

There have been pronounced fluctuations in crab production through the years, according to U. S. Fisheries statistics. There is a direct correlation between crab reproduction and the salt content of estuarine waters (37). The optimum range of salinity for hatching of blue crab eggs was between 23 and 28 ppt. Hoese (38) noted a decrease in the crab population in Mesquite Bay, Texas, during the Texas drought, when salinities were greater than that of seawater. After the drought was broken and salinities were moderately low, the blue crab population increased to its normal level.

### Primary Production

Estuaries are among the most productive ecosystems known (39). The maintenance of high productivity in estuaries is due to the "nutrient trap" created by the mixing of river waters with ocean waters. The inflow of nutrient sulfates, carbonates, phosphorus, and nitrogenous compounds via rivers contributes greatly to estuarine productivity.

Considerable amounts of organic detritus are brought into the estuary from adjacent marshes and from upstream (40). Detritus is the principal food of many estuarine organisms (39). This material is decomposed by bacteria and fungi, releasing large amounts of organic and inorganic substances which are absorbed by estuarine organisms.

Estuarine phytoplankton growth is related to terrigenous nutrients in Patuxent River and Chesapeake Bay region (41). Plankton blooms occurred just after peak flows down the Patuxent. Similarly, nutrient concentrations were higher following the peak river flow and prior to the plankton blooms. Hutner and Provasoli (42), in their review of research in algal nutrition, have verified that abundant growth of marine algae requires vitamins and nutrients in greater concentration than those found in ordinary seawater.

Estuaries in the southeastern United States are more productive near the mouths of contributing rivers (43) (44) (45) (46). It is not clear, however, whether higher productivity is because of the contribution of rivers or is because the greater mixing regenerates nutrients in that area.

On the other hand, accumulated nutrients tend to be flushed out of estuarine areas receiving large amounts of flood waters of low nutrient concentration. Such floods also kill many of the larger organisms so that their stored nutrients also are lost (38).

The productivity of Texas estuaries was lower just after heavy floods following prolonged droughts (47) (48). During times of normal river discharge, however, the algal productivity was higher than that in most estuarine areas. Texas estuaries are unique in that they are very shallow and have minimal tidal fluctuations; thus, freshwater flow is important in mixing processes.

## General Discussion

The influx of fresh water is one of the principal sources of dissolved nutrients in estuaries. The relationship of growth in estuarine phytoplankton to terrigenous nutrients is shown by the increase following periods of heavy rainfall and runoff. Organic materials, which are decomposed by bacteria and fungi to release large amounts of organic and inorganic substances that are absorbed by estuarine organisms via the aquatic medium, are brought into the estuaries by river inflow (40).

Estuaries that have proved to be important nursery areas possess a well-defined salinity gradient between river mouth and tidal pass, accomodating a large variety of species. River inflow maintains the salinity gradient to a large extent and without it the entire estuary could become hypersaline, as in the Texas Laguna Madre. On the other hand, too much freshwater inflow may cause the entire estuary to become fresh or near-fresh (Sabine Lake, in east Texas) and destroy the salinity gradient.

The estuarine systems of Texas lie in a broad arc of approximately 375 miles (600 km) and pass through a variety of climatic regions, ranging from almost fresh water in Sabine Lake to hypersaline water in the Laguna Madre. Characteristics of the five estuaries other than Sabine Lake and Laguna Madre show the effects of freshwater contributions. Since 1959, the average annual freshwater contribution to these estuaries has been 20.5 acre-ft per surface acre ($62.5 \times 10^3$ cu m/ha) for Galveston Bay, 4.4 ($13.4 \times 10^3$) for Matagorda Bay, 11.5 ($35.0 \times 10^3$) for San Antonio Bay, 1.4 ($4.3 \times 10^3$) for Aransas Bay, and 1.9 ($5.8 \times 10^3$) for Corpus Christi Bay. The large inflow in Galveston and San Antonio Bays, plus rainfall, has contributed to the maintenance of thousands of acres of marshes and bayous that provide habitat for the young of many important animals.

Galveston Bay has continually produced more oysters than other Texas bays, presumably because of the more favorable freshwater conditions. The San Antonio Bay system is the only other bay approaching Galveston Bay in producing oyster reefs. Matagorda, Aransas, and Corpus Christi Bays produce few or no oysters at the present time (27) (28). Oyster production corresponds very closely to the amount of fresh water received by each estuary.

Blue crab production was highest in the Galveston and San Antonio Bay areas, and lowest in the bays receiving the least amount of fresh water (49).

Shrimp are the most important fishery product on the Texas coast. Galveston and Matagorda Bay support the largest shrimp populations and Corpus Christi Bay the smallest. White shrimp are now almost nonexistent in Aransas and Corpus Christi Bays (receiving very little fresh water), where in years past they were quite abundant (33) (50) (51).

The data available for comparison of freshwater input and commercial fishery output are scant. However, in Texas, where freshwater input is at a critical level in most estuarine areas, some startling conclusions can be drawn. The minimum freshwater contribution required to maintain the present commercial fishery is not reached in some years in Matagorda, Aransas, and Corpus Christi Bays (Figure 3). In Galveston and San Antonio Bays, larger commercial fishery yields have been harvested during years of intermediate or below-average freshwater input.

The data presented in Figure 3 do not complete the real picture. Perhaps more important than the total commercial fisheries output is the change in species composition that makes up the total. During the year following an above-average freshwater input, shrimp and oysters make up a larger percentage of the total. These products are more valuable economically than are fish products, which make up a larger percentage of the total during years of below-average freshwater input.

Many fish species whose juveniles

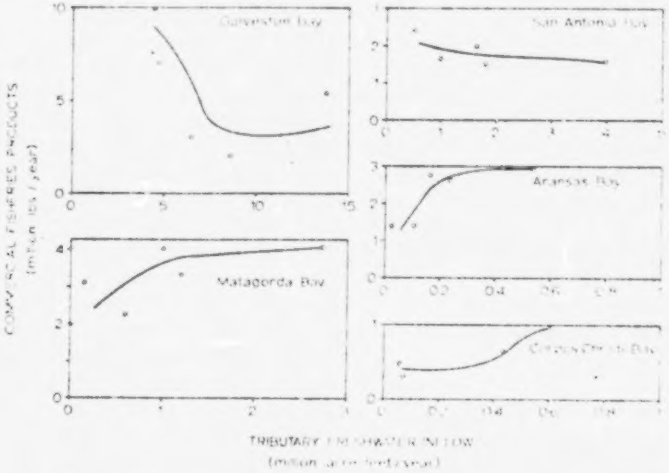

**FIGURE 3.—Commercial fisheries products vs. annual tributary freshwater inflow for Texas bays, 1959-1964. One year's freshwater contribution was plotted against the following year's commercial harvest. Solid lines indicate trends only. Data on annual commercial fishery yields were obtained from the Bureau of Commercial Fisheries, Biological Laboratories, Galveston, Texas. Data on tributary freshwater contribution to each bay were obtained from the Texas Water Commission.**

reside in low-salinity waters depend on estuaries for the completion of their life cycles (52) (53). Freshwater input is important to the propagation of fishes because of its salinity control.

Many of the same effects that have been observed in North American estuaries have been observed in estuaries in other areas. In the St. Lucia estuary system on the east coast of South Africa, serious silting and variations in rainfall, along with man's increasing demand for water, has affected the salinity gradient (54) (55). Most of the formerly rich fauna was lost because of the practices of civilization. On the other hand, Richard's Bay, just 36 miles (58 km) south, has not suffered the effects seen so clearly in the St. Lucia system (56). Presumably, this is because the river flow into Richard's Bay has not been changed by man and his enterprises.

As shown by several studies in Russia, the regulation of flow of rivers by the construction of dams led to a considerable accumulation of nutrient salts in reservoirs and to a sharp reduction in the amounts of nutrient salts flowing to the estuaries (57). Following the construction of the Tsimliansk hydroelectric dam, the biomass of the phytoplankton in the Sea of Azov was reduced by 2 to 3 times, and the zooplankton from about 600 mg/cu m to about 50 mg/cu m. Ultimately, this had an adverse effect on the feeding conditions of fishes and their populations.

An important question regarding low river flow is whether the loss of river input and the resulting higher salinities actually result in lessened productivity in the estuary or simply in changes in the productivity channels. Galtsoff (10) reported a general change in the species of oysters in bays of the central Texas coast as salinities increased during the drought of the early 1950's. With the increase in salinity there was a gradual replacement of *Crassostrea virginica*, the commercial oyster, by *Ostrea equestris*, the noncommercial oyster. In 1952 over half of the young oysters (spat) were *O. equestris*, whereas in years of normal salinity the reefs were comprised almost entirely of *C. virginica*. Gunter (58) has discussed this subject and concluded that salinity and freshwater inflow are important factors in limiting the species composition of estuaries.

As has been shown in the previous discussion, freshwater input to estuaries is an important factor. Without it, estuaries become hypersaline and species composition can be altered drastically. With continuation of man's activities in allowing less and less fresh water downstream to the estuary, man may have to pave the estuarine areas and sell them for real estate.

## Acknowledgments

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GEORGE P. MILLER
8TH DISTRICT, CALIFORNIA

MRS. ESTHER P. MILLER
SECRETARY

CHAIRMAN:
SCIENCE AND ASTRONAUTICS
COMMITTEE

MEMBER:
NATIONAL HISTORICAL
PUBLICATIONS COMMISSION

Congress of the United States
House of Representatives
Washington, D.C. 20515

February 26, 1969

Mr. Paul DeFalco
Regional Director
Pacific Southwest Region
Federal Water Pollution Control
  Administration
760 Market Street
San Francisco, California 94102

Attention: Mr. James C. McCarty, Jr.

Dear Sir:

Unfortunately, it was not possible for me to attend either of the two meetings co-sponsored by the California State Water Resources Council Board and the Federal Water Pollution Control Administration.

However, I am pleased to submit the enclosed statement, in triplicate, for inclusion in the record.

Thank you for providing me with this opportunity.

Sincerely yours,

GEORGE P. MILLER

Enc.

# STATEMENT BY CONGRESSMAN GEORGE P. MILLER
8TH DISTRICT, CALIFORNIA
BEFORE THE PACIFIC SOUTHWEST REGION
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

I have been concerned, politically and professionally, with the problems and progress of the San Francisco Bay area all my life. I was born in San Francisco. I went to college in Oakland. I represented Alameda County in the State Legislature for two terms. I became directly involved with the ecology of the Bay and its environs in some years of service as Executive Officer of the California Division of Fish and Game.

After coming to the Congress in 1944, I served on the Merchant Marine and Fisheries Committee of the House. And now on the Committee on Science and Astronautics, of which I am Chairman, we are concerned with the scientific and technological aspects of pollution abatement -- a challenging problem on which we conducted extensive and informative hearings in 1966 and 1968.

The point of these remarks is not biographical, it is ecological. It is to validate my assurance to you that I have ample cause to be deeply concerned with the subject of these hearings; that I have some knowledge of the problem in California; and that I have compelling reason to support this cooperative endeavor of the California State Water Resources Council and the Federal Water Pollution Control Administration, aimed toward our common goal of abatement and control of estuarine pollution.

My concern is with the entire Bay system -- not just the Oakland Estuary, or San Leandro Bay, or south San Francisco Bay, all of which are intimate to my 8th Congressional District. So far as pollution is concerned, none of these waters can be considered separately. They all affect each other. The whole Bay system, from the inland waters of the Delta, to out beyond the Golden Gate, is in truth one great estuary.

So, until we cease utilizing these inland waters as a master sump for sewage and waste disposal, until we really make up our minds together to clean up the Bay -- the whole Bay -- to make it look nice and smell nice again -- not until then can we begin to achieve its potential as an invaluable natural resource; as one of the great harbors of the world; as a decent habitat for water fowl and fish; as a prime recreational asset for yachtsmen, for fishermen, for visiting tourists, and for our own citizens who love to live in this marvelous environment of San Francisco Bay.

The cleanup job can be done. In fact good progress has been made by several jurisdictions -- especially the East Bay Municipal Utility District, the Ora Loma Sanitary District, the cities of Hayward and San Leandro. I commend them. But individual efforts are not enough. We need a master plan for the entire Bay system.

The State Legislature has recognized this. In the Water Pollution Control Act of 1965 it authorized a comprehensive study of the effects of waste and drainage discharge into the waters of the Bay and the Delta. The study is well along. I hope the Legislature will provide the necessary funds to complete it this year or next. I pledge my support, at the Federal level, to the joint Estuarine Pollution Control Program now undertaken by the California State Water Resources Council and the Federal Water Pollution Control Administration.

# # #

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

# SAN FRANCISCO BAY:
# WHAT WILL IT BE LIKE IN 50 YEARS?

"San Francisco Bay is an irreplaceable gift of nature that man can either abuse and ultimately destroy -- or improve and protect for future generations."

Thus begins the Plan for San Francisco Bay prepared over the past three years of study and public deliberation by the 27 members of the San Francisco Bay Conservation and Development Commission. The Commission was created by the California Legislature, through passage of the McAteer-Petris Act in 1965, (1) to prepare a Plan for the Bay, and (2) to regulate all filling and dredging while the Plan was being prepared and while it is being considered by the Governor and the Legislature in 1969.

This leaflet answers the questions most often asked about the Bay and the Bay Plan.

## Why are so many people concerned about the Bay?

Because the Bay can be made more useful than it now is -- or it can be destroyed by needless and gradual filling.

## How can the Bay be made more useful?

In several ways. The Bay can play a greater role as a major world port. Many new job-producing industries can be developed around its shores. And the recreational potential of the Bay has hardly been tapped at all: new parks, marinas, beaches, and fishing piers can provide close-to-home recreation for all segments of the Bay Area's growing population.

## What is Bay fill?

It's replacing the waters of the Bay with dirt or sand or debris to create dry land. Past diking and filling have already shrunk the Bay substantially. The Bay, including San Francisco, San Pablo, and Suisun Bays, now totals about 400 square miles in area. In 1850, before extensive diking and filling of marshlands and tidelands had begun, the Bay totaled some 680 square miles in area. (Some of the diked areas remain, at least temporarily, as salt ponds or duck-hunting preserves, but these areas have nonetheless been removed from the daily tides of the Bay, and some of them have been proposed for eventual filling.) If all parts of the present Bay less than 12 feet deep were to be filled -- all the parts described by the U. S. Army Corps of Engineers as "susceptible of reclamation" -- the Bay would consist of only 187 square miles. In some places it would be little more than a river.

## What should be done?

The Bay can be protected and enhanced only if there is a politically-responsible, democratic process by which the entire Bay can be analyzed, planned, and regulated

### MAKING A BETTER BAY

The Bay Plan provides that greater use of the Bay can be made, and important public benefits can be provided, by:

-- developing modern port terminals, on a regional basis, to keep San Francisco Bay a major world harbor during a period of rapid change in shipping technology.

-- developing sites for industries that require access to the Bay for transportation of raw materials or manufactured products.

-- developing new recreational opportunities -- shoreline parks, marinas, fishing piers, beaches, hiking and bicycling paths, and scenic drives.

-- developing expanded airport terminals and runways, if regional studies demonstrate that the growth in air transportation cannot be accommodated in any other way.

-- developing new freeways (with construction on pilings, not solid fill), if thorough study determines that no feasible alternatives are available.

-- developing new public access to the Bay and enhancing shoreline appearance through filling limited to Bay-related commercial recreation and public assembly.

as a unit. The Bay is a single body of water, in which filling one part can affect other parts. Filling that benefits a particular community or group may thus be harmful to many others.

## What are the most desirable uses of the Bay?

Priority uses of the Bay are (1) port development, (2) water-related industrial development, (3) water-related recreational development, (4) airport development (if justified by regional airport studies), (5) freeways or other crossings on pilings, not solid fill, if regional studies show the routes to be necessary, and (6) Bay-related commercial recreation and public assembly that provide new public access to the Bay and enhance shoreline appearance.

In short, the most desirable uses of the Bay are those requiring a waterfront location; uses that can just as easily be elsewhere, should be.

These priority uses of the Bay provide substantial benefits to the public, and some Bay filling may be justified for them if the same benefits could not be provided equally well without filling.

## Why not fill the Bay?

Because filling is generally harmful to the Bay -- and to man.

Filling destroys the habitat of fish and wildlife. The Bay, including open water, mudflats, and marshlands, is a complex biological system, in which tiny organisms, plants, fish, waterfowl, and shorebirds live in a delicate balance created by nature, and in which seemingly minor changes, such as a new fill or dredging project, may have far-reaching and sometimes highly-destructive effects.

In addition, filling increases the danger of water pollution. The Bay receives millions of gallons of municipal, agricultural, and industrial wastes every day. Because most of these wastes are treated before discharge, the Bay is now relatively unpolluted, at least by comparison with waterways elsewhere in the United States. But waste disposal poses a continuing threat to water quality because the amount of waste will increase as the Bay Area's population increases. Filling almost always reduces the ability of the Bay to assimilate the increasing quantities of liquid wastes being poured into it. Filling reduces both the surface area of the Bay and the volume of water in the Bay; this reduces the ability of the Bay to maintain adequate levels of oxygen in its waters, and also reduces the strength of the tides necessary to flush wastes from the Bay.

Filling can also adversely affect Bay Area weather and can increase smog. Present research indicates that filling reduces the air-conditioning effects of the Bay and increases the dangers of air pollution in the Bay Area. Filling reduces the open-water expanses over which cool air can move inland from the ocean; this reduces the amount of cool air reaching the Santa Clara Valley and the Carquinez Strait area in the summer. In addition, reducing the water surface area increases the frequency and intensity of temperature-inversions, which trap air pollutants and cause an increase in smog in the Bay Area.

## Why do people want to fill the Bay?

Partly because of the demands of a rapidly-increasing population for new, flat land in urban areas near the Bay, and partly to "broaden the tax base" of a particular community. The population of the nine-county Bay Area is now about 4.5 million; experts predict almost a doubling in the next 30 years. But there will still be no necessity to fill the Bay just to create land; less than 1/5 of the land suitable for urban use in the nine Bay Area counties is now developed.

> The Bay itself both links and physically divides the great Bay Area cities which form a unique economic community. Only artificially drawn lines of governmental jurisdiction break the continuity of Bay Area citizenship. The Bay moderates the concentration of people, giving them unity and open space. The Bay allies itself with the fog and the Pacific breezes as nature's air conditioning for San Francisco. The Bay's awesome tidal flow of two million three hundred thousand cubic feet per second is three and one-half times the flow of the Mississippi River at its mouth.
>
> San Francisco Chamber of Commerce advertisement
> in Fortune Magazine
> June 15, 1968

## How can the Bay be filled -- doesn't the public own it?

Not exactly. Parts of the Bay are owned by many individuals, many corporations, many agencies of local government, the State of California, and the Federal government. About 22 per cent of the Bay bottom is claimed by private owners as the result of sales by the State a century or more ago; another 23 per cent has been granted by the State free to cities and counties; the State now owns only about 50 per cent of the Bay; and the Federal government owns the remaining 5 per cent. Many parts of the Bay that are closest to shore, most shallow, and thus most easily filled, are held by private owners or local governments that may wish to fill for various purposes.

## Is it easy to get to the Bay?

Most people in the Bay Area live close to the Bay (about three-quarters of the people live within five miles of the shoreline) but for most people, the Bay is almost inaccessible. Probably less than 5 per cent of the 276-mile shoreline is permanently open to the public now. New access is especially needed in urban areas near the Bay where large concentrations of poor people live. The Bay Plan urges that highest priority be given to immediate recreational development in these areas throug construction of public parks, beaches, fishing piers, hiking pathways, etc.

> To the 4 million people who live in the cities and towns on its shores, San Francisco Bay is a body of water to be cherished -- sometimes veiled in soft, gray fog, sometimes sparkling with white sails, and always a soothing contrast to the clanging bustle of urban life. But in recent years, lovers of the bay, from San Rafael to Palo Alto, have had to face up to a hard fact of life: you can't have your bay and fill it, too . . . .
>
> Legislators received sacks of sand with cards reading, "You'll wonder where the water went if you fill the Bay with sediment." The result was the setting up, in 1965, of the San Francisco Bay Conservation and Development Commission (BCDC).
>
> Newsweek Magazine
> November 4, 1968

## What about shoreline lands?

If existing land bordering the Bay isn't used wisely, there will be added pressures to fill the Bay to create new land. Prime shoreline sites should therefore be reserved for priority uses -- ports, water-related industry, water-related recreation, etc. -- and not used in any other ways. Public access along the shoreline should be provided wherever feasible. And attractive design of shoreline developments should be encouraged. The Bay Plan thus recommends that the agency designated to carry out the Plan have some jurisdiction over shoreline areas.

## What about the salt ponds?

The Bay Plan provides that as long as is economically feasible, the ponds (in which sea water is evaporated by the sun, leaving salt to be harvested) should be maintained in their present use; the ponds were once part of the shallows of the Bay and still provide important habitat for wildfowl and a large expanse of water surface to help combat smog.

If, however, salt production is no longer economically feasible and the owner of the salt ponds wants to convert the ponds to other uses, the Bay Plan urges the public to make every effort to buy some or all of them, open the dikes, and return the ponds to the Bay; this represents man's last substantial opportunity to enlarge the Bay, rather than shrink it.

But if available public funds do not permit such purchases, and if the ponds are to be used for urban development, then the Bay Plan provides that substantial areas should be dedicated as permanent open water, just as streets, parks, and other areas are dedicated as a condition for land development in cities and counties.

## Will filled land be safe in an earthquake?

Virtually all fills in San Francisco Bay are placed on top of Bay mud. The construction of buildings on such fills creates a greater number of potential hazards to life and property, during normal settling and during earthquakes, than does construction on rock or on dense, hard soil deposits. But adequate engineering can reduce these potential hazards to acceptable levels. The Bay Plan recommends that, to insure construction in accordance with safety standards, all future fills be evaluated by a Fill Review Board, consisting of outstanding geologists, soils engineers, architects, and structural engineers.

> The tidal zone where America borders the sea in bays, marshes, estuaries, sloughs and flats may be the least understood and most maligned fraction of our natural world. The shallow edge of the sea where salt water mingles with fresh, commonly called the estuarine zone, is the most productive acreage known to man. It provides food and sport, moderates our weather and protects us from the weight of a storm-driven ocean. In return we dredge its shallows, pile muck onto its marshes, dam it off with highways and bulkheads and glorify our efforts as "reclamation." We aren't reclaiming a thing -- we are destroying. And unless the Congress and the states move quickly to put into law the protective measures demanded by ecologists we will have sacrificed one of our greatest wealths to create dry sterile land that the nation already has in abundance . . . .
>
> It is tragically late to recognize the problem, but there are signs of an awakening. Massachusetts has enforced, since 1965, a stiff law requiring permits for all alterations of estuarine areas. And in San Francisco, the Bay Conservation and Development Commission has had the power to veto filling projects for the past three years while it worked out a master plan for Bay development.
>
> Life Magazine editorial
> July 19, 1968

## What can private enterprise do to improve the Bay?

Private enterprise can provide industrial growth, can help finance port and airport development, can develop Bayfront housing, and can provide opportunities for commercial recreation along the shoreline. These developments will not only afford opportunities for more people to use and enjoy the Bay but will also create many new jobs. Private investment in shoreline development is vigorously encouraged in the Bay Plan.

## Is Bay filling regulated now?

Yes. The McAteer-Petris Act, which created the BCDC, specified that anyone wishing to place fill in the Bay, or to dredge in the Bay, must first obtain a permit from the Commission. (Some aspects of Bay fill are also regulated by some local governments and by the U. S. Army Corps of Engineers.) But the regional controls provided by the McAteer-Petris Act are temporary. They will expire, and the BCDC will go out of existence, 90 days after adjournment of the 1969 Legislature (i.e., late in 1969). The Bay Plan strongly recommends that a permanent regional agency be established by the State in 1969 to regulate all future filling and dredging.

## Why is 1969 so important?

Because decisions as to the future of the Bay will be made in Sacramento in 1969. The BCDC, in submitting its Plan to the Governor and the Legislature, has strongly recommended that there be no lapse in efforts begun by the State in 1965 to protect and enhance San Francisco Bay.

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**ASSOCIATION OF MONTEREY BAY AREA GOVERNMENTS**

March 10, 1969

Mr. Irving J. Terzich
Pacific Southwest Region
Federal Water Pollution Control Adm.
760 Market Street
San Francisco, California 94102

Dear Mr. Terzich:

It is indeed an honor to have the opportunity to add my remarks to the record of the public hearings on "Water Quality Management for Estuaries" held in San Francisco February 18-19, 1969. The Association of Monterey Bay Area Governments (AMBAG), which I represent, is pleased to inform you of its interest and activities relative to estuarine study, protection, and enhancement.

ESTUARINE STUDY

AMBAG has been formed, through a joint powers agreement among interested city and county governments in the area tributary to Monterey Bay, to initiate efforts to preserve the utility and beauty of that most unique body of coastal water. Additionally we are obviously concerned in a corollary fashion with the prospects for continued growth of land-based activities in the region that may contribute to degradation of the Bay's quality. We would like to be in a position eventually to point out to action agencies, including some of our own member organizations, some water quality management plans that could be undertaken in a long-term and comprehensive manner to prevent such degradation from occurring.

To do this AMBAG believes it imperative that a comprehensive study be initiated immediately, or certainly very soon, to establish

1. the static and dynamic resource inventory of Monterey Bay, including fundamental oceanographic, hydrodynamic, water quality, and

Established January 8th, 1968, to form an organization composed of governmental agencies in the Counties of Monterey, San Benito and Santa Cruz to explore pr
having a direct effect on the health, welfare and economy of Monterey Bay and its retention as a natural asset.

ecologic data describing the Bay;

2. trends in land uses and population growth in the Monterey Bay tributary watersheds, as well as the relationships between these growth patterns and the attendant changes in Bay quality that such patterns might induce if left unchecked; and

3. the relative feasibilities of alternative engineering-management plans or projects that would protect the Bay's quality from the effects of such growth or indeed that might enhance the Bay's quality in spite of such growth.

Currently AMBAG is preparing a framework plan for such a study, and will be in contact with your agency, since we know it is precisely such studies of estuarine areas as unique as Monterey Bay that are of paramount importance to you and to all the people.

ESTUARINE PROTECTION

The study that AMBAG envisions will also address some interesting regional estuarine problems involving transference of quality problems from one estuary to another. It is not sufficient, in our judgment, to protect Monterey Bay at considerable or even prohibitive cost to communities or ecologic populations elsewhere, including the near-shore ocean environment or towns and cities up and down the coast from our particular Bay.

In short, protection of our Bay must be effected through management schemes and engineering works directed toward the most efficient service to the people and economy of our region, as well as toward the minimization of imposition of our problems on other people, regions, or ecosystems. Consequently we envision that our study will require and will include the most advanced systems analysis and management tools to aid the people of Monterey Bay in making sensible and near-optimal decisions about the quality-protection options that we have or can create.

ESTUARINE ENHANCEMENT

There is little doubt but that interest in, and resources for, the type of study we believe necessary for Monterey Bay could be and should be encouraged and solicited, not only by ourselves, but by federal and state agencies as well who must cooperate with those of us in local agencies wishing to do the bidding of the people--the people who have endured their final Santa Barbara. There is no reason to believe that methods and ideas derived in our study could not be applied to estuarine areas in other parts of our state and indeed throughout the nation. It is not, we believe, too optimistic or idealistic to trust that science working at the aid of policy can lead us to an informed set of decisions about ways and means of preserving and indeed enhancing both the use and the quality of Monterey Bay for ourselves and for future generations. It is with this goal in mind that we will soon begin our study, and we can only conclude that your agencies are seeking similar goals through meetings of this kind.

Respectfully submitted,

Henry J. Mello, President
Association of Monterey
Bay Area Governments

**Moss Landing Marine Laboratories** of the
CALIFORNIA STATE COLLEGES at Fresno, Hayward, Sacramento, San Francisco, San Jose
P.O. Box 223, Moss Landing, California 95039

Office of the Director

14 February 1969

Federal Water Pollution Control Administration
California State Water Resources Control Board

Gentlemen:

On behalf of the Moss Landing Marine Laboratories of the California State Colleges, I should like to endorse in the strongest possible terms the developing federal and state programs for protection of our bays and estuaries. The intent and approach of the 1966 Clean Water Restoration Act, and the emphasis provided by Congressman Dingell's H.R. 25, clearly have placed estuary protection as a top priority concern of the Federal government. This priority has been reaffirmed in the several reports to Congress by the President on Marine Resources and Engineering Development.

A. State-level Concern for Estuarine Environmental Quality.

For purposes of the record, let me provide some elements of documentation as to State of California concern for protection of estuaries. This concern has been expressed both in general terms of resources use planning, and in a very specific way through the setting of priorities for action in the safeguarding of water quality. (Selected quotations from State documents are provided in Appendix A.)

Major actions by State and regional bodies within the last few years testify to mounting public concern for California's environmental amenities generally and water quality particularly. Certainly California's leaders are increasingly concerned about protecting the priceless values of California's nearly 1200 miles of open wave-washed coastline, and some 650 miles of additional shoreline found in sheltered bays and estuaries. All these irreplaceable assets are vulnerable to the most massive population growth pressures and technological changes that have ever faced any people any place on earth. Since World War II California has doubled in population, has shifted from a predominantly agrarian to strongly industrialized technology, and has developed highly urbanized centers to become the most populous state in the nation. Most of this growth has been concentrated along the coast, with some 13 million Californians now living within an hour's drive of the Pacific, and a coastal resident population estimated to approach 20 million by 1980.

These major state actions have included resource use policy positions adopted by the State of California Resources Agency 1965-67, and the three-volume California Fish and Wildlife Plan of 1966, certainly the most comprehensive resources planning program of its kind yet developed by any state (cf. Appendix A, pp. A-1 to A-4).

Additionally, first by executive action and later by legislative mandate, California has created a top-level Advisory Commission on marine and coastal resources, charged with policy recommendations to the Governor and to the Legislature (Governor's Advisory Commission on Ocean Resources, 1965-1968; superceded by the California Advisory Commission on Marine and Coastal Resources, 1968; cf. Appendix A, pp. A-4 to A-5).

Most recently, as recommended by the Advisory Commission, Governor Reagan has established the executive Interagency Council on Ocean Resources, composed of the heads of concerned state agencies under chairmanship of the Lieutenant Governor.

### B. Regional and Local Concern for Estuarine Environmental Quality.

Elsewhere in these hearings, I am certain that testimony will be offered concerning regional and local actions to protect the water qualities and other environmental amenities of California's bays and estuaries. Most notable of these regional approaches is that of the San Francisco Bay Conservation and Development Commission, which has made a herculean effort over the past several years to develop a long-term management plan for optimal development of this great bay.

A somewhat similar effort is now underway for Monterey Bay, where cities and counties have entered into a joint powers agreement to form the Association of Monterey Bay Area Governments (AMBAG). This organization presently is planning necessary research and management steps to protect the Monterey Bay region from destructive water pollution.

As further illustration of local initiative to solve water quality problems, state and local government, private industry, civic groups, and the general public have combined forces at Moss Landing on Monterey Bay to take steps necessary to reduce pollution of the Elkhorn Slough-Moss Landing Harbor estuarine system. This positive action follows two years of effort in defining the problems, feasible solutions to them, and in developing funding procedures which would be acceptable to the major industries of the area as well as to the general citizens.

I suggest that this successful community effort is illustrative of a new attitude toward water quality standards and near-shore environment protection. Further, I believe that it has come about in part because of the leadership provided by both Federal and State agencies in regard to water quality control. In the Moss Landing instance, State and County health departments detected and defined the pollution problem; the County Board of Supervisors created the necessary public structure to seek practical solutions to that problem; and private industry, local agencies and organizations, and individual property owners carried on the necessary dialogue to arrive at a compromise approach to funding.

In the context of today's hearings, I urge that Federal and State agencies view these examples of regional concern for estuarine water quality as convincing evidence that our national and state programs are gaining in power and effectiveness. It is vital that we capitalize on this growing momentum, and continue to press for expanded effort for the preservation of environmental amenities in our nearshore and estuarine ecosystems. Usually the needed action program must depend upon local support for viability; but very often the initial leadership and problem definition must come from national or state levels. Certainly too, since the world's oceans form an inter-communicating link among all estuaries, problems and their solution are never entirely local. Therefore state and federal standards, technical assistance, and financial participation are both necessary and desirable.

## C. Considerations of Estuary Values.

The National Estuarine Pollution Study accepts certain premises concerning value as expressed under "Frame of Reference" in the March, 1968, summary booklet. My remarks will not attempt to cover this area, but rather will provide selected documentation of three particular facets of estuary value: first, in terms of some recent dollar value estimates for nearshore waters of California; second, in terms of living laboratory values of a specific estuary for educational and scientific research purposes; and third, in terms of particular ecological significance of the shallow water areas of estuaries.

### 1. Values of California's nearshore waters.

William D. Clarke of Westinghouse Ocean Research Laboratory, San Diego, recently (September, 1967) produced an interesting assessment of uses and values for California's nearshore environment.[1] While the total figures encompass open coast as well as estuaries, still the outline of uses and the estimates of comparative values are instructive.

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[1] Clarke, Wm. D., 1967. The Nearshore Waters, California's Resource of the Future. Westinghouse Ocean Research Laboratory, San Diego, Calif. Scientific Paper 67-1C7-OCEAN-p. 1. 17 pp.

Dr. Clarke identifies, subdivides, and briefly analyzes five classes of uses of the nearshore waters:

a. Recreational (fishing, boating, swimming, camping, etc.)

b. Commercial (fisheries, kelp harvesting, oil, salt, harbors, etc.)

c. Scientific (educational, research, developmental)

d. Waste disposal (domestic, agricultural, industrial sewage, garbage, thermal and saline wastes)

e. Future uses (underwater, habitation, fresh water, aquaculture, nutrients, etc.)

Most, though not all of these have an impact upon estuaries and embayments that is greater in terms of effect per unit area than it is along the open coast. Many of these actual or potential uses are directly competing, and some are mutually excluding. All must be considered in assessing the potential value of any segment of the nearshore environment. Most will figure to greater or less extent in the decision-making process for shoreline and near-shore water management.

Dr. Clarke also includes an interesting table of comparative economic worth for various uses of the California shoreline, which accords a major economic edge to recreational uses as opposed to commercial and other more or less consumptive uses. He estimates the total annual value of California's nearshore waters in excess of one and a quarter billion dollars. More than two thirds of that value he assigns to recreational uses (887 million dollars per year, of which tourist expenditures account for 450 million, boating 316 million, sport fishing 107 million). He evaluates commercial uses at nearly 390 million dollars, with seawater cooling for power generation accounting for 213 million of that total, oil industry 138 million, and commercial fisheries 23 million.

He estimates waste disposal at sea at 9.4 million as the value of annual savings through deposition of sewage at sea as opposed to some alternate means of handling it.

Dr. Clarke's figures represent an extremely interesting effort at quantification of values. While these absolute numbers do not apply directly to estuarine situations, the comparative values may prove a useful model against which to test local problems, and through which to seek one type of criterion for decision-making. Certainly I would hope, and very strongly urge, that we would never permit ourselves to be trapped into decision-making on estimated dollar value criteria alone.

2. Uses of Elkhorn Slough-Moss Landing Harbor as a living laboratory for educational and scientific purposes.

As an example of particular values of an estuary, let me cite uses as an adjunct to the educational and scientific process of a single small embayment tributary to Monterey Bay in Central California. Moss Landing Harbor and Elkhorn Slough constitute a priceless living laboratory reasonably close to population centers of Central California, and with ready access for students and faculty of seven collegiate institutions, none more than half an hour away. This estuarine system is tiny by comparison to the enormous size of the San Francisco Bay complex, but in miniature it is a near-perfect model of a salt-water embayment, to date relatively unspoiled by single-purpose exploitative encroachments. Incidentally, Elkhorn Slough is world-renowned as the site of pioneering estuarine biological studies carried out several decades ago by the McGinities.

Three community (junior) colleges and four senior collegiate institutions use this estuary for general education of students, and as outdoor laboratory for advanced research by marine scientists and engineers. These senior institutions include the University of California at Santa Cruz, Stanford University's Hopkins Marine Station at Pacific Grove, the U. S. Navy's Postgraduate School at Monterey, and the California State Colleges' Marine Laboratories at Moss Landing. The Naval Postgraduate School is the only institution of its kind in the United States, providing M.S. and Ph.D. education for career naval and marine officers. The facilities of Stanford and the University of California serve two illustrious university systems. The Moss Landing Marine Laboratories provide marine science educational and research opportunities for students from five Central California colleges, operating the year around with a local enrollment averaging 60.

Recent estimates of educational and research uses of Elkhorn Slough indicate that college students invest nearly 5,000 man-days per year in support of their academic career objectives. These 5,000 man-days involve some 1200 college students. Many of these are on single-day field trips from schools outside the Monterey Bay area, but perhaps 200 are resident students engaged in long-term studies for which the estuary is a central living laboratory.

To these collegiate uses can be added another 2,000 man-days of high school student use, and 500 to 1000 man-days of elementary school use.

Conservative estimates for growth in these educational and research uses indicate a 50 to 60% increase over the next five years.

These use figures cannot be equated to dollars, nor should they be. Their significance in terms of investment in the future is truly incalculable.

3. Particular ecological values of shallow areas of bays and estuaries.

As final special note on values of estuaries, I should like to stress the role of marshes and mudflats in maintenance of biological health of the total system. The following is abstracted from recommendations provided in 1968 to the San Francisco Bay Conservation and Development Commission in relation to the values of bay marshes and mudflats, and provides the basis for arguments in favor of careful sequestering of these vulnerable areas against diking and filling for single-purpose exploitative purposes:

Salt marshes are extraordinarily fertile. Living marsh plants fix the energy of sunlight into their tissues through photosynthesis, and expel oxygen to the surrounding environment. Thus primary productivity is high in the marshes...

Large numbers of birds, including ducks and geese, come to the marshes to feed on the lush vegetation or on the brackish-water animals that thrive there. Their wastes, the decomposition products of plant decay, and other elements of the complex food web, contribute nutrients from the marshes to the shallows of the bay margin supporting a vast marine-life nursery.

The mudflats are converters of energy derived from nearby environments including the marshes. In addition, their moist surface provides the habitat for highly productive minute algae.

Each ebb and flow of the tide exposes these tiny plants alternately to abundant light energy and to the high nutrient content of the shallow bay waters. Each tidal interchange injects oxygen into the water, and thereby contributes to the support of marine life and the reduction of pollution.

Most marine life of the bay depends either directly or indirectly upon the marshes and mudflats for energy and for oxygen.

The wet surface areas of marshes and mudflats also provide enormous absorption surfaces for air pollutants.

I trust that these comments and suggestions will be helpful.

Sincerely,

John P. Harville, Director
Moss Landing Marine Laboratories

A-1

## STATE OF CALIFORNIA CONCERN FOR THE FUTURE OF COASTAL AND ESTUARINE RESOURCES

California's mounting concerns for nearshore waters, the coastal zone, and bays and estuaries have been reflected in actions of the past several years first to study the problems involved, and second, to mobilize resources to meet these problems. Early in 1964, Governor Brown convened a conference on "California and the World Ocean" which launched state government on an appraisal of problems and promises of California's marine environment. The Governor's Advisory Commission on Ocean Resources (GACOR) was created as result of that conference, to review and evaluate the State's goals and commitments in ocean resource development. This advisory body has been continued under Governor Reagan's administration, and in 1968 was given legislative mandate and broadened responsibilities as the California Advisory Commission on Marine and Coastal Resources.

In October, 1965, the Institute of Marine Resources of the University of California issued its comprehensive report entitled "California and the Use of the Ocean" under the editorship of distinguished scientist M. B. Schaefer. This report was a first major step toward California's development of a comprehensive master plan for effective use of the oceans and their resources. Concurrent with that publication, the Resources Agency of California issued its "Study of Resource Policy Directions for California" (December, 1965), and followed this in December 1966 with "California and the Ocean". From 1966 to the present, appropriate state agencies and the Advisory Commissions have continued to develop and implement a master plan approach to marine resources development. The most recent major step in this direction has been creation by Governor Reagan of a top-level executive body, the Interagency Council on Ocean Resources, made up of the heads of concerned state agencies under the chairmanship of the Lieutenant Governor.

The following selected notes from 1965-1967 documents illustrate California's evolving concern for estuarine resources and their protection, and in my judgment, constitute a very strong state commitment to the same basic goals embodied in Federal legislation.

1. Resources Agency of California--analysis of problems and acceptance of responsibilities.

In its 1965 "Study of Resource Policy Directions for California", the Resources Agency faced squarely the massive difficulties of population pressure and resources deterioration, and announced its plans for meeting these problems. The following quotations are appropriate for their implications for estuarine and inshore water protection.

a. Competition for Resources (pg. 3):

> "Competition for the use of the State's resources is growing at an enormous rate...Each day there are 2,000 more Californians, and each day the State loses approximately 170 acres of open farmlands for homes, factories, roads, and public facilities."

[In its 1966 publication, "California and the Ocean", the Resources Agency added these notes in specific relation to inshore marine resources (pg. 105):]

> "Approximately 13 million people now live within an hour's drive of California's Pacific Ocean shoreline, and by 1980 the population of urban communities bordering the coast will perhaps reach a level of 20 million people. The economy of the State is closely tied to the resources of the shoreline and the adjacent waters. The living inshore marine resources and the users of these resources compete with each other for space and utilization of habitat.
>
> "...Multiple-purpose use of our shoreline need not create serious conflicts of interest and problems; however, without proper planning, problems can and will develop. For example, Southern California marine sewer outfalls are currently discharging approximately one billion gallons of effluent per day, or roughly the present ocean discharge of the Sacramento River, and by 1980 this amount should be doubled."

b. The Fading Beauty of California.

> "California's almost legendary reputation for environmental amenities has been a major factor in attracting millions of people. These, plus the State's renowned system of higher education, have contributed greatly to the concentration in California of a large pool of scientific and technological "brain power"...In addition, California's unsurpassed natural beauty attracts millions of tourists each year...(1965, pg. 3)

"No great technical ability or special insight is required to perceive California's future problems--they are already quite evident. Acrid air, polluted streams, blighted cities, declining fisheries, overcrowded recreation and scenic areas, recurrent floods and fires--multiply these by ever-increasing factors of population growth and urban expansion. This is what California must endure in 1980, if it does not plan for a growth which will enable its people to live in harmony with their natural environment; if it does not prevent the destruction of the beauty which has made California a good place to live." (pg. 3)

c. Enhancement of Environmental Amenities.

"The impact of California's mushrooming population on the beauty of its environment until recently has been accepted as an inevitable result of industrialization and urbanization...The deterioration and destruction of the State's amenities since World War II is an indictment of a society which has shown an amazing capacity to meet almost every other challenge of growth and expansion. But the environmental erosion caused by past growth becomes alarming when viewed in the perspective of a California of the future which will be called upon to accommodate 40 million people. The legacy of the State's past cannot be accepted as a pattern for its future...

"Recent actions of government and elements of the private sector indicate that further deterioration of the environment and loss of beauty will not be viewed as a necessary adjunct of economic progress... However, what is needed is a means of including concern for environmental quality as an integral part of all planning and developmental programs." (1965, pg. 18)

d. Principles of Good Stewardship--Goals for California.

"Enhancement of the Quality of Life:

"It should be a goal of the State of California to preserve and enhance the quality of life of present and future citizens by preventing a degradation of the natural environment and by seeking an optimum balance between economic and social benefits to be derived from the State's natural resources... A major problem in resources management is to find the proper balance between the development of the economy and the conservation of its resources--between sound, long-run economic development and short-sighted, short-run economic overdevelopment. (pg. 17)

"Freedom of Choice for the Future:

"The wild river, virgin forest or primitive beach which is not preserved today cannot be restored by a future generation. Some decisions, not made today, can never be made... It should be the goal of the State of California to preserve for future generations the greatest possible range and freedom of choice in the use and enjoyment of the State's natural resources. (pg. 8)

"Intergovernmental Collaboration:

"There is clear need for coordination of state, federal, local, and private programs in all resources fields... It should be a goal of the State of California to find ways of organizing to promote an efficient combination of public and private efforts in seeking California's goals of resources management." (pg. 9)

"Problems of urban growth and the management of resources are interrelated... Formal procedures must be established for increased communication between the resources manager and the urban planner and for the continuous exchange of technical information...

"The State should pursue vigorously with the Federal Government the need to create a high-level inter-governmental mechanism for coordination of resources management... (pg. 25)

"The State should intensify its efforts to stimulate local governments to undertake regional planning programs, and should participate as a partner with local government in the formulation and development of regional development plans." (pg. 25)

2. Governor's Advisory Commission on Ocean Resources (GACOR) 1965-1968, and California Advisory Commission on Marine and Coastal Resources (CMC) 1968-present. As its first order of business, GACOR conducted a detailed analysis of the Institute of Marine Resources 1965 document "California and Use of the Ocean". The following quotations essentially are affirmations of GACOR support for recommendations of that document. Since GACOR represented a broad spectrum of scientists, engineers, state agency administrators, and political leaders, this support has great significance both to the State of California and to the nation.

a. Establishment of bay and estuarine preserves.

GACOR recommended that "state government accord high priority to immediate establishment of reserves in certain bay and estuarine areas that are rapidly being irreversibly modified by man's action..."

GACOR supported the statement in the Institute of Marine Resources report that 'it is important that a sufficient number and variety of typical marine habitats be set aside as marine reserves to insure the survival of all species of marine plants, invertebrates, fishes, mammals, and waterfowl to preserve the various types of communities. This is necessary in order to maintain large heterogeneous natural gene pools for the future use of mankind; to provide outdoor museums for education and public enjoyment and to supply intellectual and esthetic appreciation; to make possible scientific research on organisms and communities in their natural state." (GACOR Proceedings of Meeting IV, La Jolla, Calif., June 1966)

b. Maintenance of some marine environments for low-density use.

GACOR recommended that "some marine environments should be maintained by the State for low density use and should be protected from excessive human interference.

"The importance of this recommendation is based upon the fact that the current basis for decisions on the use and development of outdoor resources do not adequately protect either the minority or the long time values of the people of the State.

"Those who are making the decisions on the recreational use of public lands and waters need support to help maintain low density areas and wide variety of recreational opportunities... The need for action is urgent, and cannot await the development and refinement of measurement techniques." (ibid, pg. 27)

c. Waste Management and pollution control.

GACOR recommends that the State "...prepare on a routine basis a detailed inventory of all waste discharges (municipal, industrial, and agricultural) to the waters of the State. Of especial interest to GACOR is an inventory of wastes discharged to estuarine and coastal waters..." (ibid, pg. 80)

GACOR also supported the recommendation of the IMR report (pg. 2-29) for assignment of beneficial water uses and establishment of general criteria for the quality of receiving waters for those ocean and estuarine waters located near population centers.

3. The California Advisory Commission on Marine and Coastal Resources in its 1968 and 1969 reports has reiterated the high priority of all these recommendations of the earlier Commission. Additionally, the Commission and the Interagency Council on Ocean Resources in 1968 funded a preliminary study of California's coastal zone. (published in September, 1968: "California's Coastal Zone" by Bendix Bradbury Associates, and Copley International Corporation.) Finally, in November, 1968, the Commission made the following specific recommendation in relation to the urgency for a comprehensive program of environmental data collection in California's near-shore waters:

"In order to augment higher education in the marine sciences, expand field research activities of prime importance to decision-making, and provide meaningful information services to the people of California, the California Advisory Commission on Marine and Coastal Resources recommends that a coordinated program of near-shore environmental data collection and analysis be developed.

"This continuing effort should encompass the total coastline of California. It should be implemented principally by California's educational institutions so that they can provide expanded student opportunities for field research, and at the same time develop the detailed environmental inventories and relative base-line data which are requisite to effective decision-making in the development of California's coastline. However, there is no intention to exclude other state or federal agencies or industry from participating in this program.

"Institutions that assume these coordinated responsibilities will be eligible to receive augmented support from state and applicable federal sources. To implement this coordinated program, interested institutions should define the prime areas for which they will accept data collection and analysis responsibility.

"To assure early coverage for the entire coastline, agreement among the participants as to allocation of prime areas of responsibility should be reached prior to initiation of support to any single participant.

"To qualify for this special funding, institutions should direct a portion of their effort toward mission-oriented public services of direct benefit to local users of the shoreline and near-shore waters.

"To carry out this coordinated program, participating institutions should be encouraged to pool their special resources and facilities to the degree practicable.

"To assure information exchange, identification of areas requiring emphasis, and effective dissemination of data and conclusions, periodic conferences should be arranged among all participants and any other interested parties.

"Since these recommendations relate to the four segments of California higher education, the California Advisory Commission on Marine and Coastal Resources requests that these recommendations be referred through appropriate executive and legislative channels to the Coordinating Council for Higher Education for implementation."

4. Conclusion: State of California's commitment to protection of estuaries. From materials quoted here, it is apparent that this state has mobilized along a broad front to develop attitudes, principles, and criteria for effective management of marine resources, with particular attention to her increasingly endangered estuaries. The Institute of Marine Resources report specifically indicates eleven bays and estuaries which demand particular attention. California's Department of Fish and Game, in a more recent report, "California Fish and Wildlife Plan" (1966, Vol. III, pp. 782-805), has inventoried eighteen bays and estuaries, and has summarized major fisheries and wildlife resources for each. Such important groundwork by a large and powerful State constitutes significant *a priori* endorsement of the fundamental multiple-use principles the Federal Government hopes to serve through both the Clean Waters Restoration Bill and Congressman Dingell's H.R. 25 bill.

Perhaps there is no better way to summarize this state-level commitment than to quote from the covering letter of the 1967 report "The Last Frontier" submitted to the Legislature by the Assembly Committee on Natural Resources, Planning, and Public Works, Edwin L. Z'Berg, Chairman:

> "Gentlemen:
>
> "The Subcommittee on Marine Resources of the Assembly Committee on Natural Resources, Planning, and Public Works submits herewith its report to the Legislature on 1965-67 studies dealing with the conservation and development of the rich and varied natural resources of the marine and coastal environment in California.
>
> As our terrestrial resources become progressively depleted by the demands of growth, we must turn increasingly to our last frontier for the resources necessary to maintain, and enhance wherever possible, the unique quality of California life. In this venture, however, we must demonstrate that we have learned from our mistakes by ensuring that the short-term, single-purpose philosophy which presently dominates terrestrial resources management is replaced by a long-range, multiple-purpose policy guaranteeing the conservation and development of our marine and coastal resources in the total public interest.

"As the result of its study of this important and complex subject, the subcommittee concludes that there is urgent need for the formulation and adoption of a comprehensive marine resources policy by the state, and in its report recommends passage of the Marine Resources Conservation and Development Act as the first step toward this goal. The act creates the California Commission on Marine Resources, which is charged with the responsibility of formulating a long-range master plan--based upon a comprehensive, continuously updated program of research and exploration--for the balanced conservation and development of our proximate ocean resources.

"In the view of the committee, the adoption of this approach--which is consistent with that recommended in its numerous other studies of such problem areas as development in the Lake Tahoe Basin, comprehensive watershed management, highway and freeway planning, the filling of San Francisco Bay, and the regional economy of the north coast redwoods--is vital to the responsible and continuing resolution of the increasingly serious conflicts in resources allocation posed by California's explosive growth. It is clear that only through such efforts will it be possible to maintain some element of the incomparable productivity and natural beauty of the number one state for the enjoyment of future generations..."

February 18, 1969

To: Mr. Irving M. Terzich
Pacific Southwest Region
Federal Water Pollution Control Administration
760 Market Street
San Francisco, Calif. 94102

From: H. Thomas Harvey, Ph.D., Ecologist
Biological Sciences Dept. San Jose State College
representing So. Bay Wildlife Refuge Committee and endorsed by various Audubon Societies and the Sierra Club, Also V. Pres. San Francisco Bay Estuarine Association.

Re: Water quality management for estuarine areas in California

It is a privilege and a challenge to attempt to answer the five salient questions you raise regarding the estuary system of California. Though many of the following comments may apply to other estuarine areas the emphasis is on S. F. Bay. It is our greatest estuary and it is under the greatest threat of destruction.

Values Estuaries are of incalcuable value to those of us who teach ecology or conduct research in such rich and unique habitats. They posses plants with strange capacities to excrete salt and to withstand internal cellular pressures twenty times that of ordinary land plants. These land plants which have returned to the edge of the sea are apparently among the most productive of all known non-cultivated plants, capable of such fantastic yields as 10-15 tons/acre/yr.

Estuaries are known to be the nurseries for sports fish which provide recreation for thousands of people around the Bay area. Hunting and bird watching are particularly rewarding in estuarine areas of S.F. Bay. Over a hundred different species of birds can be observed along the edge of S.F. Bay. Boating, hiking and artistic pursuits all can be counted as additional recreational values of an estuary such as S.F. Bay.

All of the above can be measured in part by theeconomies which they generate. For example Mel Scott estimates that sport fishing is worth $23,000,000 a year, while hunting may be worth another $7,000,000. These are healthy economies only as the estuary is healthy, for they depend on the productivity of the estuary community, a community based on healthy marsh plants and phyto-plankton. Even the health of the citizens around the bay may be evaluated on a dollars and cents basis. Although firm figures are lacking, ecological knowledge and logic point to the dollar value of open space near metropolitan areas so that smog is reduced, water pollution is ameliorated, and the mental health of the citizens is enhanced. By leaving the estuary natural the environment is not loaded with additional pollutants detrimental to human life and thus we are saved the added expense of compensating for these pollutants. Although subject to some variation of interpretation, it presently takes about an acre of shallow water to oxidize the effluent from 200 homes. To destroy that capacity of the estuary means that we must pay to construct sewage treatment facilities to take care of it. The personal values of clean water and air are threatened by continued loss of the magnificant estuary, S.F. Bay.

To access the aesthetic value of the Bay is a most difficult task. I like mud flats, others do not. Waving marsh grasses in the evening during the fall bring forth emotional responses from most people. But what is the worth of a wild bird in flight? Who can put a price on the glory of a moonrise over the marsh? Of particular esthetic and educational value are rare and endangered species such as the red-bellied harvest mouse and the Clapper rail.

Damage by pollution It has been estimated by Ted Wooster of the Calif. Dept. of Fish and Game that over 200,000 man-days per year of recreational clam digging are lost to people around S.F. Bay due to water pollution. Commercial sewage is known to reduce numbers and kinds of invertebrates in the mud which in turn probably serve as food to other marine forms.

Personal use of much of the South Bay is foregone because of the level of pollution, with body contact sports such as swimming and water skiing unavailable. Ganssle, in 1963, suggested that pollution adversely affected salmon migration, which in turn would decrease the subsequent spawning and future populations and thus make inroads into the eventual commercial fisheries.

Future of Coastal zones I think that the major emphasis for the future development of our coastal zones should be for public uses; with preservation of large tracts of land in their natural state so that recreation, scientific study, aesthetic enjoyment and personal physical and mental health may be enhanced for the millions of citizens who already live along these coastal regions, and visitors from across the nation.

Best uses The continuing phenomenal population growth of California, especially along the coastal and estuarine areas, makes it imperative to look to the long range values of these areas. If the suggested values discussed above are valid, then the best use for the greatest number of people is a restriction of commercial develop ment and a development of use areas for the public. The plan developed by the S.F.B.C.D.C. for the S.F. Bay seems,to me,to closely approximate what I consider the best use of this great estuary.

Management Systems I think a regional system should administer the estuarine area of S.F. Bay and that State and Federal agencies might cooperatre on the management of our estuarine resources. For example, the establishment of a U.S. Wildlife Refuge in South San Francisco Bay is presently being proposed. An area of approximately 16,000 acres is suggested by a committee chaired by Mr. Paul McKeehan. A bill (H.B. 2749) by eight local congressmen supports the creation of such a federal refuge. There are numerous citizen's groups such as local Audubon Societies, Assoc. Sportsmen of California, Calif. Wildlife Federation, Sierra Club and over 240 Bay area Biological Scientists who endorse this proposal. Local jurisdictions such as Alameda Co., Hayward, and the City of Fremont have also gone on record favoring this kind of use for our estuarine resources.

Summary A major ecologically stabilizing feature of our coastal zones in California is the estuarine areas. They may serve to enrich our lives by providing a healthy environment not only for the wild plants and animals which may abound there (if we but control our pollution),but,for man himself.

**RESOURCES AND ECOLOGY PROJECTS**

P. O. BOX 97, MILL VALLEY, CALIFORNIA 94941
Telephone: Area Code 415 – 388-1340
Joel F. Gustafson, PhD

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February 18, 1969

Statement of Joel F. Gustafson, presented to public meeting on Water Quality Management for Estuaries at San Francisco, California on February 18, 1969.

My name is Joel F. Gustafson and my occupation is that of a Professor of Ecology and Systematics at San Francisco State College. I also serve as the Associate Dean, School of Natural Sciences. My statements here today refer to my activities at the college, but I do not officially represent the college. I am also the owner of a consulting business titled "Resources and Ecology Projects".

We are very much concerned over the rapid disappearance of both salt marshes and estuaries and lagoons. Our concerns are based upon the significance of these segments of the natural world as distinct and valuable habitats as well as their importance to man as areas of recreation and a host of less easily defended values. We have some understanding of the overall values of estuaries in marine biology, yet we are very weak in specific information. The generalization are easily formed. However, without specific facts for support we are open to many challenges opposing our points of view.

Many of us have been and are engaged in efforts to develop the breadth and depth of our information regarding both estuaries and salt marshes.

My first exhibit presents an action taken by the Pacific Coast Entomological Society in 1967. This Society established a "salt marsh habitat committee" of which I am chairman. The Society has encouraged the submission of notes and observations regarding salt marsh insects and other terrestrial invertebrates to the editor of its journal - The Pan Pacific Entomologist. Accepted articles will be printed without cost to contributors. This action is an obvious attempt to encourage both studies and the publication of data regarding the salt marsh habitat. Nearly 100 notices of this action have been sent to other societies and groups with the suggestion that they might wish to take similar actions. This Society will attempt to emphasize studies of central California.

Mr. Robert S. Lane is nearing completion of a Master's degree program at San Francisco State College. His research involves a study of the insect populations of a salt marsh in South San Francisco Bay. Currently this salt marsh is leased by the National Audubon Society as a wildlife sanctuary. The study area is located immediately south of theDumbarton railroad bridge in Alameda County. Locally, nearly all of the vegetation of our salt marshes consists of three species of plants. The middle elevations are nearly entirely occupied by pickleweed. This plant makes up the major proportion of our salt marshes. Aside from its several values of providing space, loafing grounds, retreat and protection, it is the least valuable biologically of the three major species of salt marsh plants. The data being developed by Mr. Lane demonstrate that the invertebrate populations associated with cordgrass are several times higher than those produced by the other plants of the salt marsh. Since the insects are so important as food sources for birds in the estuarine habitat, particular concern should be directed toward an understanding of the roles played by those plants which support the highest insect population. Today, cordgrass makes up a very small percentage of our salt marsh areas. The primary reason for the small area occupied by cordgrass is the diking which encloses nearly all of our bay area salt marshes. Studies conducted at salt marshes in the southeast and on the Atlantic coast have demonstrated an overwhelming importance of cordgrass versus the other salt marsh plants (said studies were concerned with roles in trophic food cycles). Cordgrass is almost completely utilized by organisms of the estuarine environment. Only a portion of the pickleweed plants are similarly utilized. Mr. Guy Cameron, a graduate student at the University of California at Davis is conducting a similar study to that of Mr. Lane. Mr. Cameron is studying a salt marsh area near Petaluma Creek on the shores of San Pablo Bay. There are a number of significant differences in the animals which Mr. Cameron is collecting versus those which Mr. Lane has found. Both of these students have secured the very generous assistance of the same specialists in classification across the country. Despite the close geographic approximation of these two salt marshes, there are significant ecological differences between them.

My second exhibit consists of a report (the second of three) concerning the ecology of Bolinas Lagoon, Marin County, California. This report contains data on the utilization by fish of the lagoon and its one permanent stream. Three studies are summarized in this report. That of Mr. Ken Adams concerns the relationships of larval fish occurring in tide flats supporting large concentrations of a seaweed called sea lettuce. Mr. Ed Fineman's data is concerned with a year-long survey of fish utilizing a permanent stream which enters the lagoon. I have directed a year-long study of the fish populations in one of the two major drainage channels in the lagoon. All three of these studies have demonstrated the month by month importance of these 3 kinds of waters to a variety of species of fish, all of which are important either as game fish or as rough fish utilized by other wildlife. I direct your attention specifically to pages 9 to 12, which summarize data concerning the organisms inhabiting mud flats and sand flats. These species were identified by members of the California Academy of Sciences in San Francisco. The data is based upon 411 core samples at 31 stations located throughout the lagoon; and pages 14 to 15 which summarize data on several species of clams, the most significant finding being that nearly all clams are of a similar age - there being approximately 8 years during which no year classes were successful. The data on fishes are summarized on pages 22-28. The data clearly demonstrate the year-round use of the lagoon by fish. This contributes support to the concept that these shallow waters are nursery grounds for wildlife. Pages 29-34 summarize data demonstrating the utilization by shore birds and game birds during the winter months.

These latter studies have appeared in a research contract report. Portions of several of them will be published in appropriate research journals.

My last exhibit refers to the work of Professor James Mackey of San Francisco State College, which summarizes 3 years of study of Corte Madera Creek in Marin

County. His studies are concerned with the utilization of this creek by a large number of fish. Again, his data indicate that at frequent periods throughout the year this creek, which empties into San Francisco Bay, is utilized by different species of fish throughout the year. Some of the fish spawn within the fresh waters of the creek. Some species hatch in the shallow estuarine waters and utilize the creek water during portions of their larval life. Again, the evidence clearly demonstrates the significance played by subsections of this total bay area environment on a year around basis.

I am pleased to state that the flood control district of San Mateo County and Santa Clara County have cooperated in an ecological approach in their planning of a flood control program of San Francisquito Creek. Necessary flood control developments and the materials to be used will permit a co-existence of nature and flood control developments if present efforts come to fruition.

The U.S. Army Corps of Engineers have scheduled a preservation of the natural condition of the lower reaches of Corte Madera Creek in Marin County. In the flood control developments of this creek the corps has programmed a vegetation redevelopment of the banks and shores. The vegetation closest to the bay will be native species of plants. The vegetation in the other areas consist of species which are important wildlife plants (food and shelter) and are also attractive from the standpoint of landscaping.

The last two illustrations demonstrate that ecologists can play an important role in land-use planning when they have the facts to support their points of view. In regard to salt marshes, mud flats and shallow waters, the result of our land-use planning must result in the setting aside of significantly important areas for their ecological values. We need many more facts to substantiate our opinions regarding their value from an ecological standpoint. If developed, I am confident that the data will allow ecology to compete with industry and housing.

SAN FRANCISCO STATE COLLEGE
1600 HOLLOWAY AVENUE • SAN FRANCISCO, CALIFORNIA 94132

November 20, 1968

Editor:

Dear Sir:

The following notice is submitted for publication.

## THE SALT MARSH HABITAT

A Special Project of the Pacific Coast Entomological Society

At a meeting in 1967 of the Pacific Coast Entomological Society, a lecture on the ecology of the mud flat - salt marsh habitat was presented. Following this meeting, a number of the members expressed concern regarding the rapid disappearance of this habitat due to commercial development. Subsequently, a salt marsh habitat committee was appointed to stimulate studies in central California.

The Society is now sponsoring publication of notes and observations on salt marsh insects (and other terrestrial arthropods) for publications in the Pan-Pacific Entomologist. Articles should be submitted to the editor of the journal, California Academy of Sciences, San Francisco, California, 94118.

An annotated bibliography of California species of salt marsh insects will appear in Volume 44, No. 4, 1968.

It is our hope that entomological societies in other geographic locations will undertake a similar interest and sponsorship of articles on the salt marsh habitat.

Joel F. Gustafson, Professor
Ecology and Systematics, SFSC
Chairman, Salt Marsh Habitat Committee
Pacific Coast Entomological Society

# ECOLOGICAL STUDY

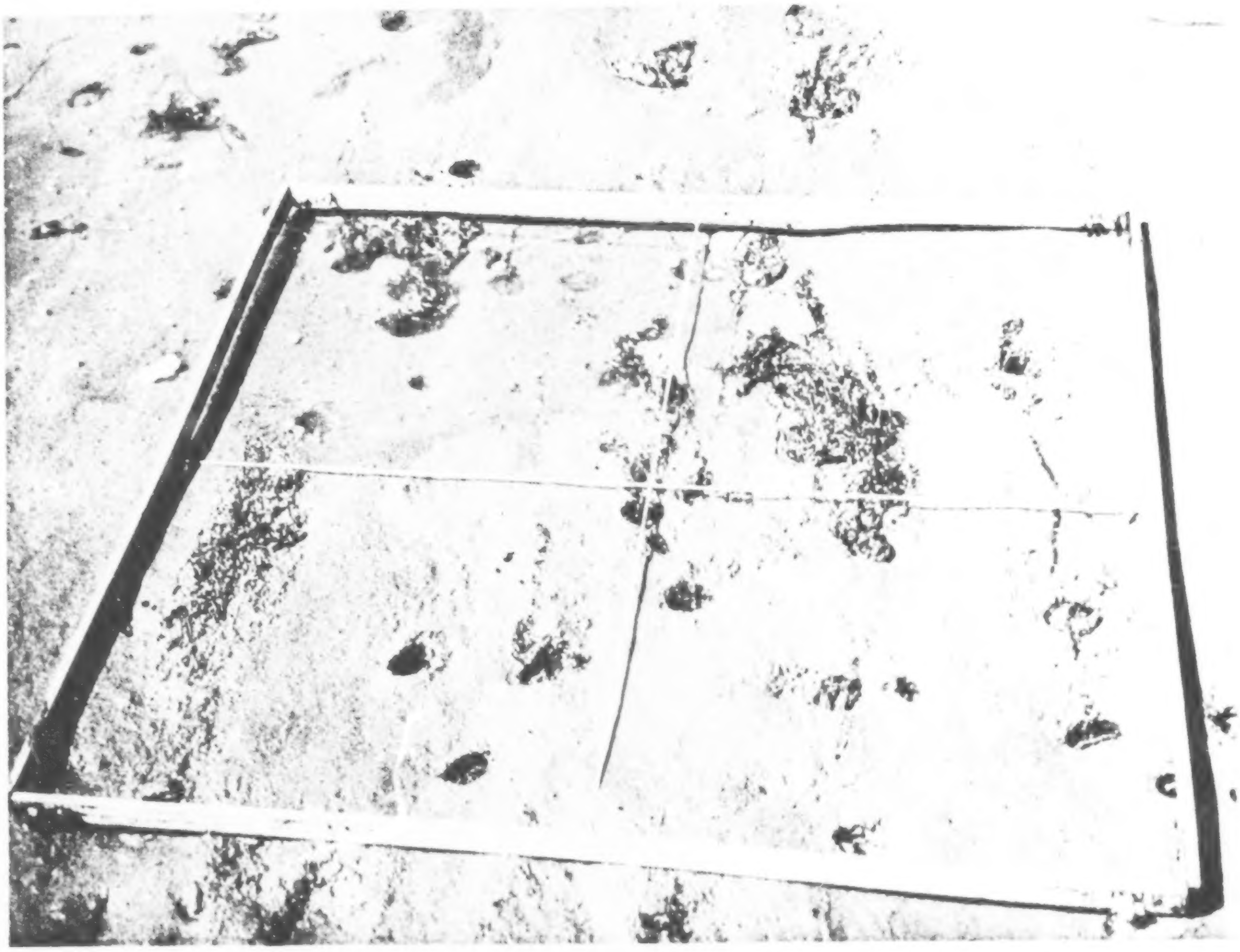
## BOLINAS LAGOON, MARIN COUNTY, CALIFORNIA

Clam diggers between Pickleweed Island and Stinson Beach

**RESOURCES & ECOLOGY PROJECTS**
J. F. GUSTAFSON, Ph.D.
P.O. Box 97, Mill Valley, California
October 3, 1968

Sections d, e.

Study supported by:
Audubon Canyon Ranch
Bolinas Harbor District
County of Marin
Marin Conservation League



There are 36 gaper clam siphon holes within this square meter. The 5-8" clams are 2-3' down in the muddy sand. The gaper is named *Tresus nuttallii*

# ECOLOGICAL STUDY OF BOLINAS LAGOON

## Report number two

Acknowledgements:

We are indebted to a very large number of individuals: professional scientists, students and volunteer naturalists. Their names are recognized in the appropriate sections.

Special appreciation is expressed to:

Mr. H. G. Orcutt, Department of Fish & Game, Marine Resources Operations Laboratory

Professor Richard Doutt, University of California, Berkeley

Mr. Al Molina, Director of Bolinas Marine Laboratory and Chairman of the Biology Department, College of Marin, Kentfield

Mr. Craig Hansen of the Bolinas Marine Laboratory

and to students of College of Marin and San Francisco State College

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In a previous report (February 1, 1968) the history and nature of Bolinas Lagoon were discussed. In that report the marshland and upland vegetation as well as dependent terrestrial vertebrates were discussed.

This document, the second report on the "Ecological Study of Bolinas Lagoon," will contain sections D and E of the RESOURCES AND ECOLOGY PROJECTS study contract.

Section D: Mapping of habitat areas in the lagoon
1. Listing of marine invertebrates by habitat and role
2. Listing of marine vertebrates
3. Listing of marine plants by habitat

Section E: Key index species: importance in major trophic cycles, distribution frequency, role and sensitivity to pollutants.

In the preparation of the report, it became clear at the outset that so much information had been developed that it appeared more desirable to change the arrangement of the subjects treated.

Reference to the table of contents will disclose the more logical development in covering the subjects. The section on sensitivity to pollutants will be treated in the following section F for the same reasons.

A number of physical and chemical discussions are necessary as background information prior to presentations and interpretations of the field work relating to the key species of the lagoon plant and animal life.

## BOTTOM CONDITIONS

The selection of 31 areas within the lagoon for sampling of invertebrate populations was made on the basis of criteria designed to provide the widest possible sampling of the bottom life throughout the lagoon.

The nature - the consistency - of the bottom is regarded as important along with the quality of the water in determining the quantity and the variety of life forms living within the bottom material.

Sediment particle size measurements and percentages of the total volumes were made for all but one of the stations. In the latter instance (station #16) over 25% of the volume of each sample consisted of fragments of tules, bulrush, sedges and other plant debris, with the major percent (75%) being fine silt and fine organic fragments.

Sediment collections were made on October 27, 1967, and November 10, 1967. Samples were taken with a 10 cm x 15 cm piston corer (diameter and length). Samples were sieved through 5 metal screen sieves of descending mesh sizes as follows:

|  | Sieve inches | Mesh sizes millimeters |
|---|---|---|
| 1. | 0.530 | 13.5 |
| 2. | 0.250 | 6.3 |
| 3. | 0.065 | 1.651 |
| 4. | 0.0331 | 0.84 |
| 5. | 0.0165 | 0.420 |

Each sample was washed under a water faucet until no further passage of particles occurred. Invertebrates were collected from each sieve and then the contents were examined as to color, texture and nature. Some station samples contained significant percentages of finely ground shell fragments (primarily of clams and cockles.)

| Station | Total cc. | Sieves #1 % | #2 % | #3 % | #4 % | #5 % | Remainder in fines, clays, plant debris |
|---|---|---|---|---|---|---|---|
| 1a | 850 | - | + | + | + | 0.02 | 0.98 |
| 1b | 970 | 0.13 | 0.21 | 0.21 | 0.08 | 0.05 | 0.34 |
| 2 | 1000 | 0.10 | 0.15 | 0.13 | 0.06 | 0.25 | 0.32 |
| 3 | 850 | 0.06 | 0.12 | 0.03 | 0.02 | 0.07 | 0.69 |
| 4 | 1100 | 0.03 | 0.15 | 0.16 | 0.10 | 0.20 | 0.37 |
| 5 | 1200 | + | + | 0.01 | 0.01 | 0.17 | 0.81 |
| 6 | 1100 | - | + | + | + | 0.70 | 0.29 |
| 7 | 950 | + | - | + | + | 0.02 | 0.98 |
| 8 | 1000 | + | - | + | + | + | 0.99 |
| 9 | 900 | - | - | + | + | 0.01 | 0.98 |
| 10 | 1200 | - | 0.01 | + | - | 0.75 | 0.24 |
| 11 | 950 | - | - | - | - | 0.26 | 0.74 |
| 12 | 1000 | - | - | - | + | 0.03 | 0.96 |
| 13 | 1100 | - | + | + | + | 0.59 | 0.40 |
| 14 | 1000 | 0.23 | 0.20 | 0.03 | + | 0.01 | 0.53 |
| 15 | 900 | - | + | + | + | 0.02 | 0.97 |
| 16 |  |  |  |  |  |  |  |
| 17 | 1100 | - | - | + | + | 0.73 | 0.27 |
| 18 | 900 | 0.61 | 0.22 | 0.03 | + | + | 0.13 |
| 19 | 900 | - | - | - | + | 0.94 | 0.05 |
| 21 | 1000 | - | - | - | + | 0.40 | 0.60 |
| 22 | 1250 | + | _ | + | + | 0.44 | 0.56 |
| 23 | 1000 | _ | - | + | 0.02 | 0.25 | 0.73 |
| 24 | 1500 | - | + | + | + | 0.40 | 0.59 |
| 25 | 1100 | + | 0.14 | + | 0.04 | 0.64 | 0.17 |
| 26 | 1300 | + | + | 0.12 | 0.10 | 0.35 | 0.43 |
| 27 | 1150 | + | + | + | + | 0.26 | 0.72 |
| 31 | 1300 | - | 0.01 | + | + | 0.35 | 0.63 |
| 32 | 1700 | - | - | + | + | 0.35 | 0.64 |

Clays are mineral particles finer than 0.002 mm in size. It is apparent that the very soft mud deposits of stations 21-27 contain a considerable portion of fine clays. See map for location, description and comments. Totals do not always equal 100% due to rounding off of figures.

The following chart illustrates the changes that occur seasonally within the lagoon. The stations reported in this chart show that some areas are relatively stable in so far as erosion or deposition are concerned (e.g. #'s 2, 7, 9 and possibly 5). Some stations show significant changes, especially #'s 17, 18, 19, 22 and 24. The first stations are sandy locations: 5 - near the old pier by Leonards place, 7 - west of Pickleweed Island, 9 - the sand flat to the north of the island, and 2 - the face of Kent Island. Stations 17 and 19 are in the channel behind Kent Island. Stations 22 and 24 are near the intersection of Highway 1 and the Bolinas turnoff at the northern end of the lagoon (see station map).

Particle sizes, spring versus fall
Stations showing greatest changes

| Station | | Sieve Sizes | | | | | | |
|---|---|---|---|---|---|---|---|---|
| # | Month | 1 | 2 | 3 | 4 | 5 | Rem. | Total |
| 2 | Apr. | 150 | 150 | 175 | 75 | 225 | 325 | 1,100 |
| | Oct. | 100 | 150 | 125 | 55 | 250 | 320 | 1,000 |
| 5 | Apr. | 4 | + | + | 10 | 10 | 1076 | 1,100 |
| | Oct. | - | + | 12 | 10 | 200 | 977 | 1,200 |
| 7 | Apr. | + | + | + | + | 50 | 1045 | 1,100 |
| | Oct. | + | - | + | + | 14 | 932 | 950 |
| 9 | Apr. | - | - | + | + | 20 | 1168 | 1,100 |
| | Oct. | - | - | + | + | 10 | 882 | 900 |
| 17 | Apr. | - | + | + | + | 25 | 1065 | 1,100 |
| | Oct. | - | - | + | + | 800 | 296 | 1,100 |
| 18 | Apr. | 140 | 150 | 250 | 50 | 75 | 435 | 1,100 |
| | Oct. | 550 | 200 | 25 | + | + | 121 | 900 |
| 19 | Apr. | + | + | + | + | 10 | 983 | 1,000 |
| | Oct. | - | - | + | + | 850 | 47 | 900 |
| 22 | Apr. | + | + | + | + | 20 | 1075 | 1,100 |
| | Oct. | + | - | + | + | 550 | 692 | 1,250 |
| 24 | Apr. | - | + | + | 10 | 10 | 988 | 1,000 |
| | Oct. | - | + | + | + | 600 | 889 | 1,500 |

It is therefore quite apparent that we have both deposition and scour (erosion) in a number of locations, seasonally within the lagoon.

The important question at this point is - are these seasonal changes leading toward a significant change in the direction of circulation and the amount of tidal waters contained. That is, is the lagoon filling up with sediment? The answer is yes in many areas. Some degree of control over tidal scour is required to offset that of deposition.

## CHANNELS IN BOLINAS LAGOON

### Introduction

The bottoms and sides of the channels in a lagoon are subject to considerable scouring - erosion - as the ebb (outgoing) tide gains its maximum velocity.

The most extreme case of this is shown at the mouth of the lagoon. Here, during both incoming (flood) and outgoing (ebb) tides, the bottom of the channel is much like a gravel chute. Many tons of sand are lifted up into the water while rocks and shell fragments are rolled in or out along the channel floor.

To lesser extents, all of the channels within the lagoon are swept on each tide. The bottoms tend to be muddy sand in the north (Olema) end, becoming more coarse in texture and with the addition of more and more shell fragments and pebbles (and less silty mud) as one approaches the ocean side of Kent Island.

The life on the deeper channel bottoms is limited - as one might expect considering the abrasive movement of sand, shell fragments and rocks during tidal flows. In the more shallow channels, we find a marked increase in living organisms, especially clams. This increase - versus the population on adjacent shallower flats - is probably due to the absence of removal by clam diggers. These distributions will be further discussed in the sections on transects within the lagoon.

In summary then, in this lagoon, there are no marked distinctions other than those mentioned between the life or physical features of the bottoms of the channels versus the adjacent sand or mud flats.

### Method

Bottom samples in all major channels were taken with an Ekman dredge, a clam-shell, spring-operated bucket with a 6" x 6" opening.

Samples of 500 cc were placed in a plastic screen with one mm mesh openings. The screen was then folded into a bag and the material was washed in lagoon water to remove the mud, sand and fine plant and shell fragments.

Collections were labeled and preserved in 70% alcohol.

No distinctions were noted in the station descriptions. There were no unaccountable variations in the animal life of the flats versus the channels. There were many more algae, especially _Ulva_ spp. (sea lettuce) and _Enteromorpha_ spp. ("grass"), on the shallower flats while _Gracilaria_ (Mermaids hair) was more common within the shallow channels.

Channel conditions (converted from centimeters to the nearest inch)
Channel mouth 1-28-68; all others 7-20-68

Channel mouth Secchi disk 30 cm (1'), depth 3 m (9'10")
very rocky, large shell fragments, some sand, no organisms

in front of post house on Stinson Beach
Secchi disk 90 cm (2'11"), depth 90 cm (2'11")
sandy with some shell fragments, few worms

off indentation of north face of Pickleweed Island
Secchi disk 210 cm (6'11"), depth 310 cm (10'2")
sandy, finely ground shell fragments, few organisms

off north center face of Pickleweed Island
Secchi disk 210 cm (6'11"), depth 1010 (33'2")
sandy, finely ground shell fragments, few organisms

near Highway 1 on south side of sand bar opposite oyster racks
Secchi disk 100 (3'3"), depth 100 (3'3")
sandy mud with large quantities of Ulva, many crustaceans, some worms
unable to get bottom sample without Ulva

in Olema end in line with dump, end of 2nd gravel bank on Highway 1, and Wilkins Barn
Secchi disk and depth 40 cm (4')
muddy with plant fragments, amphipods common

off Flow meter in center of Olema end
Secchi disk 100 cm (3'3"), depth 210 cm (6'11")
muddy, sand, shell fragments, plant debris, few organisms

off north end of big duck blind in Olema end
Secchi disk 105 cm (3'5"), depth 450 cm (14'9")
sand, shells, plant debris, few organisms

off Flow meter on Highway 1 near Audubon Canyon Ranch
Secchi disk 105 cm (3'5"), depth 210 cm (6'11")
fine sand, shells, plant fragments, few organisms

off oyster rack on west side of sand bar
Secchi disk 120 cm (3'3"), depth 210 cm (6'11")
fine sand, shell fragments, few worms and amphipods

## Scour, Erosion, Deposition

The dynamics of circulation within the lagoon are much like a large partly filled down pillow. The contents (water in this case) and flow will shift from one area to another as subtle changes in the bottom occur.

Any deposition on the bottom of a channel will slow the flow of water through that channel. At the same time, this will be compensated for by an increase in flow in one or more of the other channels. The flood tide - so named because it floods the land - is not as fast moving or as capable of scouring or eroding as the ebb (out-going) tide. The reason for this is especially well shown in a lagoon. The tides rise and fall more quickly offshore (because of lack of restrictions) than within the lagoon. The speed of the incoming waters is exceeded by the speed of the outgoing waters. This is due to the rapid fall of the Bolinas Bay, offshore waters, and a delayed runout of the Bolinas Lagoon waters. In a rather casual timing, it appears that low tide within the lagoon is delayed for over one and one half hours beyond that of the ocean. Consequently, erosion and subsequent deposition are more pronounced on the outgoing versus the incoming tides. According to the U.S. Geological Survey the velocity of the outgoing tide is 1½ times that of the incoming for Bolinas Lagoon.

This phenomenon was indicated very clearly within the lagoon during the past year - July, 1967, to July, 1968. The channel behind (north of) Kent Island, that also extends along the town of Bolinas, was subjected to considerable deposition during the winter of 1967-8. This was most evident in the channel just north of the flow meter. Here, sometime between February 21 and March 20, 1968, some 1 meter (3') of sandy material was deposited within the channel. By April of 1968 this newly deposited material started to move out of the lagoon. By July a 60 cm (2') channel was reestablished against the south bank. This channel was shallow but not as shallow at the same area in July of 1967. The Olema end of this channel which connects with a large channel near the big duck blind, was about 1'-2' deep at mid-tide last year. This year, it has not yet (August) been possible to take an outboard up that end of the channel except at high tides. Along Highway 1 leading from Stinson Beach toward Olema, collecting stations that were mostly rocky prior to November 18, 1967, became quite muddy and remained so until after March of 1968. In this case, the rocky road-fill area was covered with silt in winter. In late spring, the silt was removed by tidal scour.

During this same period, there was a diverted flow of a greater amount of water that had to escape from the lagoon by way of the channel along Highway 1 and across the north face of Pickleweed Island, a small island opposite Leonard's place. From December, 1967, to April, 1968, the north face of the island was eroded some 4'. By July this island had lost some 6' from the north face. This area now receives the major outflow of the southeast and northwest ends of the lagoon. Due to the increased velocity, as described previously, the island is being cut away on its north face.

A similar degree of erosion and deposition occurs seasonally at the channel mouth. The shape and extent of the west end of Stinson Beach undergoes great seasonal change. These changes are being studied by the U. S. Geological Survey.

In the previous report (February 1, 1968) I stated that I believed that the primary sources of sediments now filling the bay were obtained from the Bolinas Mesa bluff and from Stinson Beach. In the latter case, sand movement was by both tide and wind into the lagoon. A report soon to be released by the U.S. Geological Survey will present a mass of data that supports this opinion.

It is clear at this time that some degree of water flow control by man is indicated if we desire to maintain the lagoon in its best physical and biological condition. This last sentence is stated in the belief that given proper planning, and funding for manipulative devices, there is adequate space within the lagoon for boating, a harbor, wildlife preserves and fishing.

## Lagoon Waters

Measurements of water conditions of the lagoon were made November 24, 1967, January 28 and February 23, 1968.

These measurements were made at the request of the U.S. Geological Survey.

### Method

Conductivity-Salinity-Temperature measurements were made with a Model RS5-3 Salinometer, Industrial Instruments, Inc. Conductivity was measured in millimhos/cm, salinity in 0/00, temperature in °Centigrade. Wind measurements were taken with a Dwyer Wind Meter. Turbidity (suspended material in water) was measured with a Secchi disk. Temperature of air and water were measured with a mercury thermometer.

### Results

A selection of the data provided to the U.S. Geological Survey is included. This data shows a very similar condition of the water throughout the lagoon. Temperatures and salinity are virtually the same at the surface and at the bottom.

Winds of only a few miles per hour may cause turbidity (lift of mud and debris from the bottom) over the shallow mud flats and sand flats. Winds of 8-12 m.p.h. may cause turbidity readings of only 10-15 cm deep over mud flats. Winds in excess of 16 m.p.h. will produce turbidity of 10 cm or less.

Turbidity in the lagoon is always high. Clouded waters are typical in this lagoon. Except over sandy bottoms, turbidity levels are about half that of the depth, even when winds are less than 5 m.p.h. At 10-12 m.p.h. turbidity levels are half the depth over mud flats, at more than 16 m.p.h. turbidity levels are 1/4 or less the depth - depth being 40-100 cm.

A mild rain - a drizzle of several days in January, 1968 - did not reduce the salinity to any significant degree.

Driving rains of several days duration in February, 1968, caused a reduction in salinity of one third to one half (.1%-.2%) that of normal levels (.3%).

Runoff of fresh water from the creeks entering the lagoon was not as significant in salinity reduction as the much larger volume of general surface runoff from all of the surrounding uplands.

Bolinas Lagoon, Water Conditions

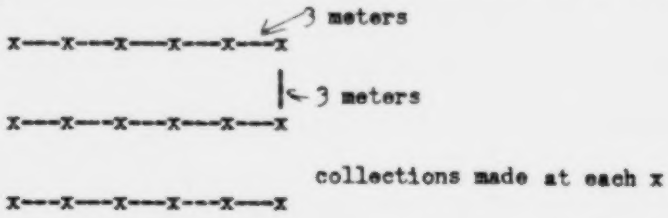
| Stations | Conductivity | Salinity | Water | Air | Wind | Secchi Disk, cm | Depth cm |
|---|---|---|---|---|---|---|---|
| Mouth | | | | | | | |
| Nov. 24, 1967 | 37.5 | 31.02 | 13.6 | 14.5 | 0 | 183 | 427 |
| Jan. 28, 1968 | 29.6 | 27.5 | 8.6 | 9.0 | 8-10 SW | 30 | 3 m |
| Feb. 23, 1968 | 29.3 | 23.3 | 14.8 | 18 | 5 | 30 | 335 |
| Bolinas Channel | | | | | | | |
| Nov. 24, 1967 | 37.66 | 31.1 | 13.75 | 16.5 | 0 | 183 | |
| Jan. 28, 1968 | 30.2 | 30.5 | 9.7 | 8.5 | 8-12 SW | 105 | 2.1 m |
| Feb. 23, 1968 | 23.0 | 17.4 | 15.6 | 21 | 8-10 | 20 | 20 |
| Big Duck Blind | | | | | | | |
| Nov. 24, 1967 | 38.5 | 31.42 | 14.24 | 15 | 0 | 27 | |
| Jan. 28, 1968 | 32.5 | 30.7 | 8.55 | 9.0 | 10 S | 70 | 70 |
| Feb. 23, 1968 | 21.0 | 15.4 | 17.9 | 20.5 | 0-5 | 25 | 52 |
| Flow Meter, Olema end | | | | | | | |
| Nov. 24, 1967 | 37.94 | 31.94 | 13.0 | 15.5 | 2-6 | 122 | |
| Jan. 28, 1968 | 32.85 | 31.75 | 7.5 | 8.0 | 18-22 S | 10 | 40 |
| Feb. 23, 1968 | | | | | | | |
| lagoon surface: | 19 | 13.55 | 17.5 | 20.5 | 0-5 | 25 | 52 |
| " bottom | 20 | 14.5 | 17.6 | " | " | " | " |
| Flow Meter, H. 1 Audubon | | | | | | | |
| Nov. 24, 1967 | 38.0 | 31.8 | 13.2 | | | 150 | |
| Jan. 28, 1968 | 32.9 | 31.0 | 8.6 | 8.0 | 22 S | 10 | 40 |
| Feb. 23, 1968 | 23.75 | 17.6 | 17.0 | 20 | 4-5 | 30 | 80 |
| Pickleweed Island | | | | | | | |
| Nov. 24, 1967 | 37.64 | 31.0 | 13.9 | 14.5 | 0 | 107 | |
| Jan. 28, 1968 | 33.25 | 31.0 | 8.6 | 8.0 | 10-16 S | 75 | 75 |
| Feb. 23, 1968 | 36.1 | 27.45 | 14.7 | 21 | 0-2 | 28 | 28 |
| Seadrift bridge | | | | | | | |
| Nov. 24, 1967 | | | | | | | |
| Jan. 28, 1968 | 23.6 | 22.5 | 8.0 | 9.0 | 10-16 SW | 10 | 20 |
| Feb. 23, 1968 | 13.8 | 10.3 | 14.3 | 17 | 0 | 30 | 60 |

## INVERTEBRATE POPULATIONS

### Purpose

Bearing in mind that there are some 600 acres of lagoon (in addition to some 1,100 acres of marshland) in Bolinas Lagoon, a method of sampling the bottom life was necessary.

We used a standard random-grid method. Grids consisted of 3 lines or transects, 3 meters apart. Collections were made at every 3 meters along each of the lines.



A deliberate bias was introduced in selecting the positions of the stations throughout the lagoon. Since the egrets and herons feed so frequently in the northwest or Olema end of the lagoon, one-third of the stations were established there. All stations were established on the basis of geography, the nature (texture) of the bottom and position in regard to shorelines and drainage channels. The intent was that we should sample as many distinctly different areas as possible. (See map following)

### Method

A piston-core sampler was designed. This consisted of a brass tube 10 cm. in diameter and 15 cm long (4" x 6"). A plunger and rod in the upper end forced the sample material out of the tube. Samples were collected at every 3 meters according to the grid plan previously described. Samples or cores were placed immediately in 2' square plastic screens. The screen mesh size was approximately 1 mm (1/25 of an inch). The screens were then folded into a bag and sloshed or washed up and down in lagoon water to remove the mud and sand. The remaining substance was then placed in a jar, preserved in 10% formalin and labeled as to location and date.

Graduate students at San Francisco State College sorted the organisms from the rocks, shells, algae, etc. The specimens were then sorted in the first approximation at classification. Each kind was counted and volumes were calculated by fluid displacement. Each kind was placed in vials in separate jars by stations. This sorted material was then taken to the California Academy of Sciences.

Under the direction of Mr. Allyn Smith and Mr. Dustin Chivers and Mr. William Light, species determinations were made. Mr. James Carlton identified the amphipods. Others in the Academy assisted in identification.

The species were then tabulated by me as to station and frequency of occurrence. I am solely responsible for the interpretations of the data.

Particles were sized at each station, as described in the previous section.

Four hundred and eleven cores were obtained from 31 stations as follows:

a. stations 16, 21-29, 32 : 6 cores each

b. station 15 : 9 cores

c. stations 1-14, 17-19, 25, 31 : 18 cores each

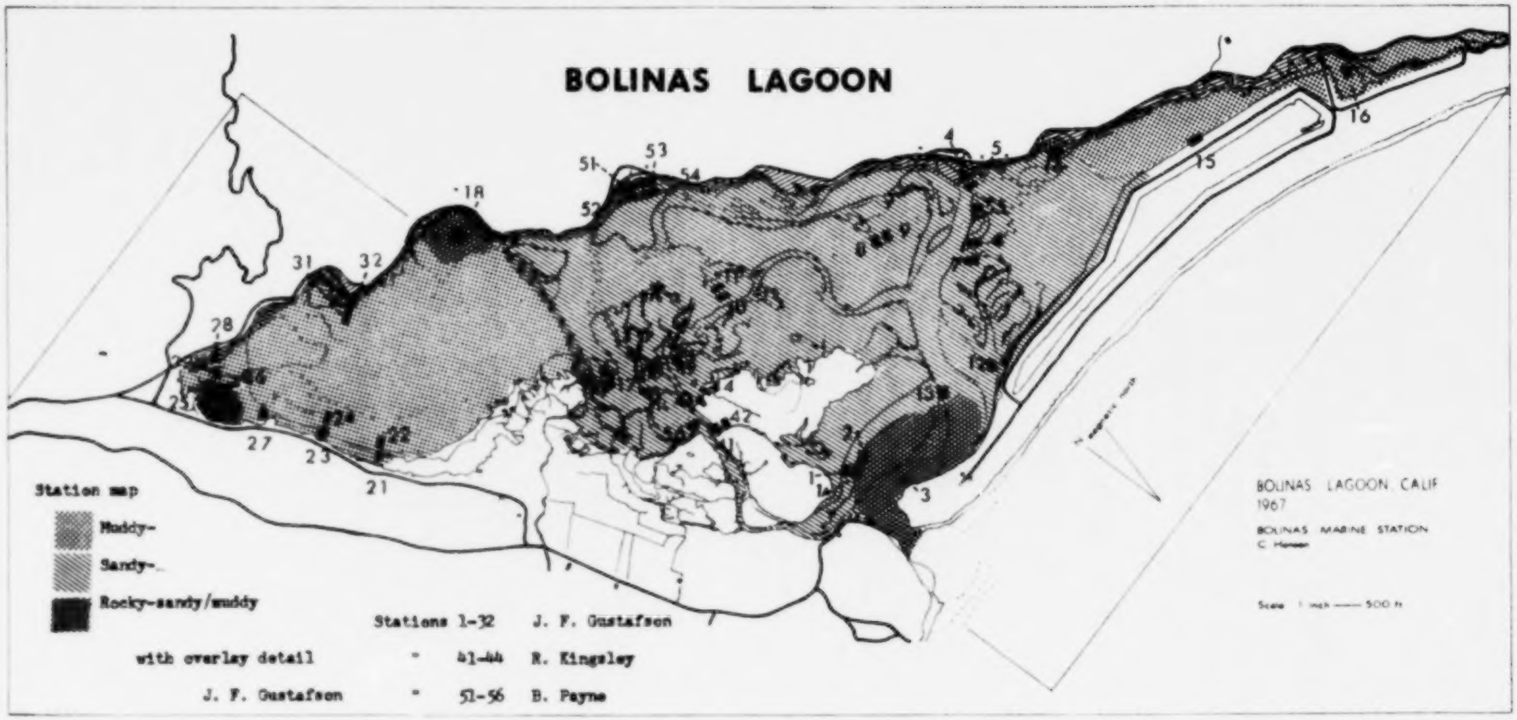
Stations in group "c" were samples according to plan.

Station 15 extended into water too deep to collect, and so only 3 samples were obtained on each transect.

Stations in group "a" were located in extremely soft mud. Movement in this sloppy, soft material was extremely difficult. We wore chest high waders, walked on our knees, and held onto a boat or canoe for partial support in these areas. Under these conditions, we quickly decided to use only 1 of each of the 3 transects planned for each station. Although stations 18, 25 and 31 were in this area too, there were sufficient rocks and other materials in these locations to allow the full 18 core sampling.

The dimensions of the corer were selected because discussions with a number of experienced marine zoologists all agreed that: most of the life involved in trophic food cycles - consumption by birds and fish - would be surface forms; a larger number of smaller diameter cores would give a better sampling (statistically) than a smaller number of large diameter cores. Consequently we decided on the corer, as described, and a series of grid samples, as described, as the methods most likely to produce the most valid sample of the life that was the most significant ecologically.

The distributions of the invertebrates did show definite relationships with the ratios of mud to sand. However, the distributions of the species of invertebrates within an area appeared to be random.


BOLINAS LAGOON
BOLINAS LAGOON, CALIF
1967
BOLINAS MARINE STATION
C. Hansen
Scale 1 inch —— 500 ft
Station map
Muddy-
Sandy-
Rocky-sandy/muddy
Stations 1-32 J. F. Gustafson
with overlay detail " 41-44 R. Kingsley
J. F. Gustafson " 51-56 B. Payne
16
15
4
5
53
51
54
52
18
31
32
28
25
27
23
21
22
42
14
13
12
1
3

## STATION DATA

| Station Number and Consistency | | Invertebrates Collected | Cores collected and sized |
|---|---|---|---|
| 1a | sandy, shell fragments | 8-8-67 | 11-10-67 |
| 1b | sandy, shell fragments | " | " |
| 2 | sandy-rocky, shell fragments | " | " |
| 3 | very rocky with sand & pebbles, shell f. | " | " |
| 4 | rocky & muddy, sand, plant fragments | " | " |
| 5 | " " " " " | " | " |
| 6 | sandy with some mud | 8-9-67 | " |
| 7 | " " " " shell fragments | " | " |
| 8 | " more mud, plant fragments | " | " |
| 9 | " " " " " | " | " |
| 10 | " " " " " | " | 10-27-67 |
| 11 | " " " " " | " | " |
| 12 | sandy, shell fragments | 8-22-67 | 11-10-67 |
| 13 | sandy, " " | " | " |
| 14 | very rocky, mud, sand, shell & plant f. | " | " |
| 15 | sandy, some plant fragments | " | " |
| 16 | mucky, ¼ to ½ plant debris and mud | " | not done |
| 17 | sandy & mud, fine shell fragments | " | 10-27-67 |
| 18 | rocky & sand, mud, plant fragments | " | " |
| 19 | sandy & mud, fine shell fragments | " | " |
| 21 | mucky, plant fragments | 8-31-67 | " |
| 22 | " " " | " | " |
| 23 | pebbles, muck and plant fragments | " | " |
| 24 | " " " " | " | " |
| 25 | rocks, pebbles, sand and mud | " | " |
| 26 | small rocks, sand & mud, plant fragments | " | " |
| 27 | mucky & plant fragments | " | " |
| 28 | " | " | " |
| 29 | " | " | " |
| 31 | rocks, mud, shell and plant fragments | " | " |
| 32 | mud | " | " |

There were no stations numbered 20 and 30.

## Summary and Interpretation

I estimated the relative ecological importance of the bottom organisms on the following basis:

a. relative abundance at more than 5 stations
b. frequence of occurrence in fish stomachs
c. frequence of occurrence in bird stomachs
d. information obtained from the scientific literature

On the basis of the criteria listed above, a selection has been made of the "key or index" species within the bottom (substrate) [illegible] the lagoon.

Many other organisms are abundant at several areas throughout the lagoon. At this time however, I am not able to assess a high level of importance ecologically to them since I lack the necessary information for such judgement. All life within the lagoon must have a role somewhere in the overall picture. Not enough is known as to who does what to what or to whom or when. There are many subjects here for future studies. In no sense do I discount the biological value of any life form.

We obtained over 44 species of segmented worms (annelid), several species of ribbon worms (Nemertea), 2 species of loph worms (Phoronida), 19 species of crustaceans, 3 species of insects (Arthropoda), 16 species of clams and snails (Mollusca) and several species of small phyla. This list is small when compared to that we could have obtained say at the adjoining Duxbury Reef. But then, lagoons are typical for having very large numbers of a small number of species.

No attempt was made to sample the organisms of the salt marsh or shore above the high tide line. We did not collect on piles or floats. Our study was directed toward an analysis of the mud flat and sand flat.

Additional studies are now under way by several graduate students at San Francisco State College. When these studies are complete, over 1,400 core samplings will have been made in mud flats, sand flats and salt marsh habitats. These are additional studies, not included under the present study.

Another bottom study made by Rembert Kingsley, a candidate for the master of arts degree at San Francisco State College, compared the invertebrate populations found in the mud flats adjacent to cord grass, Spartina foliosa, with those in front of pickleweed, Salicornia virginia.

## Method

Collections were made at 2 week intervals from 3-28-66 to 11-4-66. Three, square meter plots were established in the mud flats immediately in front of two beds of the above-named salt marsh plants. Each square meter was divided into 25 areas. Each area was numbered. A random table of numbers was established for sampling. Ten 8-ounce beer can cores were collected from each station on each sampling date - a total of 320 cores were obtained. Cores were sieved through a 20 x 20 inch mesh screen under running water. Specimens were preserved for later identification to species.

## Results

There was a much greater abundance of life in the mud in front of the cord grass than that in front of the pickleweed. This difference is best shown by the polychaete worm, Lubrineris zonata. Fifty-five of these worms were obtained from the cord grass mud flat, while only 1 was obtained from the pickleweed mud flat. Similar findings were obtained also for amphipods and mud crabs.

Mrs. Kingsley is mid-way in a year-long comparative study of the bottom organisms in drainage canals of cord grass and pickleweed areas.

We suspect that we will find a similar difference in the relative abundance of bottom organisms. The purpose of these studies is to show the relative wildlife values of salt marsh plants and their adjacent mud flats. At this time, cord grass areas appear to be much more important in terms of food production values. The pickleweed areas have other values such as providing retreat and loafing grounds, as well as a minor role in food productivity.

## Molluscs

Clams, cockles and mussels are filter feeders - straining particles out of the water. Mussels are attached to rocks, floats, piers, etc. Cockles are buried a short distance in the bottom. The 7 kinds of clams occur from surface positions down to 3 or more feet (90+ cm).

Many molluscs have been collected. We were concerned with their location, frequency, age and any other observations that we could note, e.g., relationship to bottom conditions.

The following data show a very uneven age distribution of four species.

Of 146 gaper clams, Tresus nuttallii,
none at stations 21-32, primarily in sandy-mud stations
age: range 5 (2 specimens), 15 (2 specimens), most 10-13,
median age 11 years
lengths: 7-20 cm, most 14-15, median 14 cm
weights: 67-1000 gms, most 375-600, median 475 gms

Of 197 Washington clams, Saxidomus nuttalli
none at stations 21-32, primarily in sandy-mud stations
age: 5-14, most 11-12, median 11 years
length: 8-18 cm, most 11.5-12, median 12 cm.
weights: 50-950 gms, most 300-450, median 375 gms

Of 205 cockles, Clinocardium nuttallii
none at stations 21-32, primarily in road fill along Highway 1, south of Audubon Canyon Ranch
age: 1 (2 specimens), 10 (1 specimen), most 4-5, median 5 years
length: 2.5-5.5 cm, most 4-5, median 4 cm
weights: 5-65 gms, most 15-30, median 25 gms

The uneven representation in age in the gaper and Washington clams is as yet unexplained. Fraser and Smith (reported in Ricketts & Calvin 1949, p. 267) examined 2600 British Columbia Saxidomus giganteus. They reported that aside from a larger number at 7 years, that the age distribution from 4-10 years was fairly even.

MacGinitie & MacGinitie (p. 49, 1949) feel that larval clams are consumed by the many predators (including their parents) before they have time to establish themselves. That is, the larval clams could establish themselves only in a new unoccupied area. Most of the larvae are of course washed out to sea by the tides. This concept appears attractive when one recalls the even aged appearance of mussels, barnacles and the large clams. However, the idea looses support when one considers the very large number of individuals of many species of worms and crustaceans that co-exist, all in the same area. Surely we cannot assume that all of the organisms in a lagoon are the same age. I have no explanation for the unevenness of age groupings in the larger clams.

Fraser and Smith (Ricketts & Calvin, p. 241, 1952) also made a study on the age composition of 760 basket cockles, Clinocardium nuttallii. Most of them were 3 or 4 years old, none more than 7 years. Fraser suspects that the larvae settle on the sublittoral zone and migrate upward - inshore - on reaching 2 or 3 years of age.

This may be a more likely explanation. It is well known that lagoon organisms also occur at many locations along the coastline. It may be that the survival of migration is high only in lagoons. There is as yet no evidence for this opinion.

There are distinct relationships to the molluscan populations and the particle size and nature of the bottom sediments.

Of the four prominent molluscs, all are more numerous in stations consisting of sandy mud bottoms. None are present in muddy bottom areas. Fewer are present in sandy and rocky areas. This would indicate a preference - or rather a higher survival - of those larvae that settle on semi-coarse bottom locations.

Since many of the game species of molluscs produce and release their sex cells in August, it is possible that the plowing of appropriate areas could greatly increase the larval survival rate on newly upturned coarse bottoms.

Mollusc Studies - Mrs. G. Payne

Six stations have been sampled for molluscan populations for a full year period by Mrs. Payne. The method followed that of Gustafson, pgs. 1 and 9. In this case, stations consisted of 3 transects, each line of stations being 1 meter apart. The station consisted of 18, 1 $m^2$ stations. Sampling was determined by rolling a die to select which meter was to be sampled. A similar piston rod cover was used for obtaining each sample.

Stations were selected to expand the nature and geography of those previously selected. Stations 51-54 were rocky, road fill areas along the side of Highway 1 (see map), Station 55 was on the south end of Pickleweed Island. Station 56 was some 100 m northeast of the flow meter in the Bolinas channel, behind (north of) Kent Island.

Monthly data was obtained. Notations were made as to the frequency of occurrence of dead, juvenile and adult species of mollusks. Specimens less than ¼" in length were recorded as juveniles. Most of the specimens located at these stations (near high tide line) were juveniles. Does this mean that the juveniles migrate to deeper locations (in regard to tide), or does this mean that many juveniles cover extensive areas and that survival to adult stages occur at deeper (lower) levels?

In this study 252 cores were collected and analyzed.

All species determinations were confirmed by Mr. Allyn Smith of the California Academy of Sciences, San Francisco, California.

Condition of tides, cloud cover, air and water temperatures were recorded for each collection. The station study areas did not sample known populations of other mollusks. The larger clams - Washington and gaper - occur at many locations but at greater depths than these study areas. Similarly, the attractive snail, *Olivella biplicata* occurs in some sandy bottom locations at deeper zones. An additional number of mollusks occur on pilings, posts, etc. These populations were not sampled. The preceeding lists and data then, are to be regarded as information relative to the 6 stations described.

SPECIES OBSERVED IN BOLINAS LAGOON BY BETTY PAYNE

| | |
|---|---|
| *Acanthina spirata* (Blainville) | occasional |
| *Acmaea digitalis* Escholtz | " |
| *Acmaea paradigitalis* | " |
| *Cerastoma foliatum* (Martyn) | " |
| *Cerethidea californica* (Haldeman) | abundant |
| *Clinocardium nuttalli* (Con.) | " |
| *Cryptomya californica* (Con.) | " |
| *Gemma gemma* Totten | occasional |
| *Littorina scutulata* Gould | abundant |
| *Macoma inconspicua* (Brod. & Sow.) | rare |
| M. *inquinata* (Deshayes) | rare |
| M. *nasuta* (Conrad) | abundant |
| M. *secta* (Conrad) | occasional |
| *Meretrix lusoria* | rare |
| *Mya arenaria* Linne | " |
| *Mytilus edulis* Linne | abundant |
| *Nassarius mendicus* cooperi (For.) | occasional |
| *Olivella biplicata* Sowerby | abundant |
| *Panope generosa* Gould | rare |
| *Pododesmus macroschisma* (Deshayes) | rare |
| *Protothaca staminea* (Conrad) | abundant |
| *Saxidomus nuttalli* (Conrad) | abundant |
| *Tapes japonica* (Deshayes) | " |
| T. *semidecussata* | occasional |
| *Tegula funebralis* (A. Adams) | rare |
| *Thais canaliculata* (Duclos) | occasional |
| T. *emarginata* (Deshayes) | rare |
| T. *lamellosa* (Gmelin) | occasional |
| Tresus nuttallii (Conrad) | abundant |

TOTAL OF ALL COLLECTIONS #1 THROUGH #15

| | Station #51 Live | Station #51 Dead | Station #52 Live | Station #52 Dead | Station #53 Live | Station #53 Dead | Station #54 Live | Station #54 Dead | Station #55 Live | Station #55 Dead | Station #56 Live | Station #56 Dead | Total Live | Total Dead | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Acmaea digitalis* | | 1 | | 1 | | 4 | | | | | | | 0 | 6 | 6 |
| *Acmaea paradigitalis* | | | | | 1 | 2 | | | | | | | 1 | 2 | 3 |
| *Amphissa columbiana* | | | | | | | | | | 1 | | | 0 | 1 | 1 |
| *Cryptomya californica* | | 2 | 26 | 71 | 19 | 174 | 14 | 1065 | 8 | 192 | 14 | 66 | 81 | 1570 | 1651 |
| *Gemma gemma* | | | | 1 | | | | 3 | 1 | 15 | 1 | 1 | 2 | 20 | 22 |
| *Hinnites multirugosus* | | | 1 | | | | | | | | | | 1 | 0 | 1 |
| *Lacuna carinata* | | | | | | | | | | | 1 | | 1 | 0 | 1 |
| *Littorina scutulata* | 124 | 475 | 7 | 17 | 155 | 267 | 1 | 9 | | | | | 287 | 768 | 1055 |
| *Macoma inconspicua* | | | | | 1 | | 2 | | 1 | | | | 4 | 0 | 4 |
| *Macoma inquinata* | | | | 1 | 2 | | 1 | 3 | | 1 | | | 3 | 5 | 8 |
| *Macoma nasuta* | | | 2 | 6 | 6 | 21 | 5 | 11 | 9 | 11 | 2 | 4 | 24 | 53 | 77 |
| *Macoma secta* | | | | | | 1 | | | | | | 2 | 0 | 3 | 3 |
| *Mytelis edulis* | | | | 1 | 2 | 4 | 1 | | | | | | 3 | 5 | 8 |
| *Nassarius mendicus cooperi* | | | | | | 2 | | | | | | | 0 | 2 | 2 |
| *Protothaca staminea* | | | | | 1 | 4 | 13 | 20 | | 1 | | | 14 | 25 | 39 |
| *Tapes japonica* | | | | | 3 | 1 | 2 | | | | 1 | | 6 | 1 | 7 |
| *Tapes semidecussata* | 1 | | | | 1 | 1 | 1 | | | | | | 3 | 1 | 4 |
| Unidentified juveniles | | | | | 1 | | 2 | 2 | | 5 | | 2 | 3 | 9 | 12 |
| TOTALS | 125 | 478 | 36 | 98 | 192 | 481 | 42 | 1113 | 19 | 226 | 19 | 75 | 433 | 2471 | |
| | 603 | | 134 | | 673 | | 1155 | | 245 | | 94 | | 2904 | | |

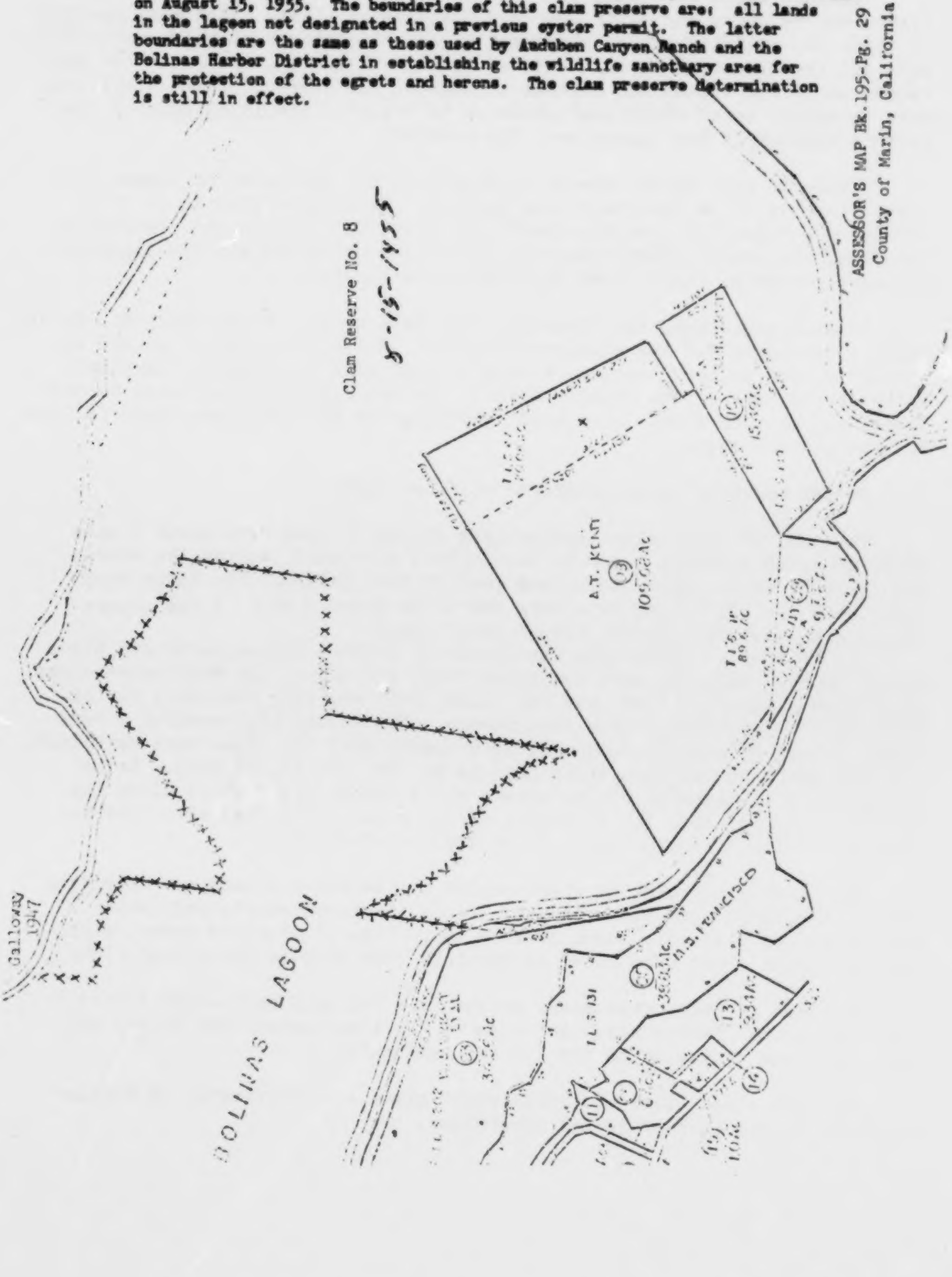
## SOIL COMPARISONS OF FOUR MONTH INTERVAL *

| | November 1967 | March 1968 |
|---|---|---|
| **Station #51** | | |
| Sec. 1—Grid 6 | solid gravel | sandy mud to small gravel |
| Sec. 2 | loose rock and gravel | " " " " " |
| Sec. 3 | mud, few rocks | blue mud to med. gravel |
| **Station #52** | | |
| Sec. 1 | rocky gravel | sandy mud to med. gravel |
| Sec. 2 | gravel to mud | " " " " " |
| Sec. 3 | mud on gravel | viscous mud to sm. gravel |
| **Station #53** | | |
| Sec. 1 | gravel, little mud | sandy bl. mud to med. gravel |
| Sec. 2 | loose rock on mud | " " " " " |
| Sec. 3 | gravel on mud | viscous mud to med. gravel |
| **Station #54** | | |
| Sec. 1 | rocks on gravel | sandy grey mud on med. gravel |
| Sec. 2 | gravel on mud | " " " " " " |
| Sec. 3 | mud on rocks | " " " " " " |
| **Station #55** | | |
| Sec. 1—Grid 3 | sandy mud | sandy mud |
| Sec. 2 | " " | " " |
| Sec. 3 | " " | " " |
| **Station #56** | | |
| Sec. 1 | all sandy silt | all sandy silt |
| Sec. 2 | " " | " " |
| Sec. 3 | " " | " " |

Note: Station #56 was originally located downslope from a 3-foot berm. Sometime between February 21 and March 20, the entire station was covered over with three feet of silty sand so that now the station is level with the pickleweed area upshore. This station was also extending into a leg of the channel and this leg has filled in, leaving the station about twenty yards from the channel. This explains why no organisms were found in the collection of March 20, but by April 8, there was evidence by the collection and by the presence of holes, that the marine animals were populating the area.

* page 7 of Payne report to J. F. Gustafson

A clam reserve No. 8 was established by the California Dept. of Fish and Game on August 15, 1955. The boundaries of this clam preserve are: all lands in the lagoon not designated in a previous oyster permit. The latter boundaries are the same as those used by Audubon Canyon Ranch and the Bolinas Harbor District in establishing the wildlife sanctuary area for the protection of the egrets and herons. The clam preserve determination is still in effect.


ASSESSOR'S MAP Bk.195-Pg. 29
County of Marin, California
Clam Reserve No. 8
5-15-1955
A.T. KENT
109.68 Ac
Galloway 1947
BOLINAS LAGOON

Transects - additional to 31 coring stations

Transect walks were made over the muddy sand flats, sand flats of the lagoon and by canoe and skiff over mud flat areas. These walks were designed to check the validity of the placement of the 31 stations at which cores were made and the extent of certain beds of bottom animals and the extent of sand versus sandy mud versus mud bottoms throughout the lagoon. These activities were necessary as an additional check as to the wildlife importance of the various regions of the lagoon and its marshes.

Transects were lines "drawn" between points. Square meter frames with cross lines at 20 cm intervals were carried. At intervals of 10 or 30 or 100 meters, depending upon the abundance of the bottom life and the size of the flat, the square meter frame was placed on the bottom and the organisms (or more properly, their tubes or holes) were counted.

On most occasions, the transects were made by me. On several, Mr. Bruce Luke, a candidate for the masters degree at San Francisco State College assisted me, and on two occasions a team of four made simultaneous parallel walks across some of the broader flats. The two additional walkers, Stephen Siegel and Kenneth Adams, were also candidates at San Francisco State College for the masters degree.

On the basis of these transects we noted that:

The beds of gaper clams extend from the muddy sand bars about ½ mile south of Audubon Canyon Ranch to the Stinson sand spit, across the shores and channels to the east, south and west of Kent Island. The large sand flats east of Kent Island have very few or no gaper clams. A few gapers occur in the Bolinas channel behind Kent Island.

The triangular muddy sand flat south of Audubon Canyon Ranch and along side Highway 1 contains very few gaper clams and only a few Washington clams. Local clam diggers tell me that the clams "went out when the ghost shrimp came in." This probably is a coincidence. The island has received a very heavy harvest by clam diggers. It is probable that the clams were harvested. The blue ghost shrimp population here is 9, 122, 30, 15, 42 (holes to be divided by 2), averaging 43/sq. meter, while the adjacent shore along the road was 108, 88, 160, 66, averaging 52/sq. meter. The flat also supports large populations of amphipod and mud crab crustaceans.

The large sandy flat at right angles to the above island and extending over to the large duck blind is very low in its invertebrate population. Four transects yielded a count of no clams. Beds of phoronid worms, amphipods and joint worms were noted as distinct beds on this large sand flat.

The beds of Washington clams extend from the sand bars about ¼ mile south of Audubon Canyon Ranch and a short distance toward Kent Island and then south and southeast to the Stinson sand spit.

The bent nosed clams and other small clams are distributed in similar areas but extend further in all directions.

The little neck clams and the mud cockles are restricted almost entirely to the rocky road fill of Highway 1 from the shore opposite the wreckage of the dredge behind Stinson Beach and north toward Audubon Canyon Ranch.

Blue ghost shrimp occur in the same areas as that listed immediately above, and across the north end of Pickleweed Island and throughout its adjacent flats close to tidal channels. The major beds of this shrimp occur on the delta of Pine Gulch Creek, extending south from the end of the creek and toward the Bolinas Channel north of Kent Island. The blue ghost shrimp is also common on the muddy sand flats east of Kent Island.

Large beds of phoronid worms, Phoronopsis viridis, occur in muddy sandy flats immediately north of channel north of Pickleweed Island, and in beds in shallow channels immediately south, and southwest of Pickleweed Island, and in shallow channels north of "Post House," and north of the west end of the lagoon inside the sand spit. Large beds of the joint worm, Axiothella rubrocincta, were found in the sand flats west and southwest of Pickleweed Island as well as common in the flats east and northeast of Kent Island.

Neither of these worms were adequately sampled in our 31 coring stations. Phoronids were counted up to 1440/sq. m; joint worms occurred up to 9600 worms/sq. m. Amphipods were counted at numbers up to 12,210/sq. m.

The Pine Gulch Creek delta supports a number of distinct "beds" of life. Mattings of algae, termed varves, occur alongside the several branches of the creek mouth as it subdivides and distributes its minor flow over the delta. Mud crabs, Hemigrapsus oregonensis, occur in very large numbers between the mats of the algae. To the north and east, the percent of mud (to sand) increases rapidly as does also the population of amphipod crustaceans. To the south we found large beds of blue ghost shrimp, intermixed with few to large numbers of mud crabs. All of the delta is a very rich wildlife food source. Large numbers of seagulls, shorebirds, coots and egrets and herons can be observed feeding there.

The data of the transects when combined with that of the 31 coring stations demonstrate an overwhelming abundance of invertebrate life. Less value is attributed to the mudflats (stations 21-32 at the Olema end of the lagoon) in contrast to the sandier flats adjacent to Kent Island and between Pickleweed Island and SE to SW toward Stinson Beach.

The impression that we have seen again and again is the greater abundance of the bottom life in those regions adjacent to channels. We are drawn toward the opinion that ideally, the greatest production would be obtained with a series of low rectangular flats, bordered by channels up to 6' (about 2 meters) in depth.

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MacGinitie, G. E. & Nettie MacGinitie 1949 Natural History of Marine Animals. McGraw-Hill Book Company, Inc.

Ricketts, E. F. & Jack Calvin 1949 Between Pacific Tides. Stanford University Press.

## Fish - sharks and rays

Leopard sharks, *Triakis semifasciata*, dogfish, *Squalus suckleyi*, and bat stingrays, *Myliobatis californicus*, were caught by fish and line, set hooks, and set lines. Unproductive methods attempted were by nets, seines and electric shocking. From 40 to 300 hooks were used by 3 to 10 fishermen. On five dates, 4 or more fishermen obtained no fish! One of these dates was in winter, two were in spring and two were in summer. On one of the summer dates there was a strong wind. The weather was "good" on the other days with no fishing success.

The sharks were with one exception all leopard sharks. All stingrays were bat stingrays.

All fish were identified, sexed, measured, condition of female gonads recorded and stomach contents obtained, preserved, and later identified at San Francisco State College. Specialists at the California Academy of Sciences confirmed identifications. I am indebted to Mr. and Mrs. Hubert Calahan and the family and relatives of Mr. and Mrs. Walter Josephs for many days of assistance on the clam and fish studies.

Shark data: 83 specimens, Oct. and Dec. of 1967, Feb., March and May of 1968

Total lengths measured in cm.
of 52 females, 34 were less than 100 cm, range 54-99 cm, gonads immature
of 18 over 100 cm, range 101-128 cm, 9 had gravid ovaries
4 of those had young numbering 12, 12, 12, 21

of 31 males, 20 were less than 100 cm, range 59-97.5 cm
11 were more than 100 cm, range 100.5 to 121 cm

Stomach contents:
of 83 stomachs, 6 were empty, total contents 4906 cc, average 59.1 cc

principal foods:
red ghost shrimp occurred in 35 stomachs
blue ghost shrimp occurred in 15 stomachs
cancer crabs occurred in 25 stomachs, probably eaten outside the lagoon
unidentifiable crustaceans in 7 additional stomachs
worms, all species, in 11 stomachs
Washington clam siphon tubes in 7 stomachs
gaper clam siphon tubes in 22 stomachs
small octopi in 2 stomachs
unidentified molluscs (in addition) in 7 stomachs
fish in 7 stomachs
fish egg masses in 6 stomachs
algae in 2 stomachs
rocks in 1 stomach

Comments:

The principal foods are crustaceans and molluscs. Sharks may be opportunistic according to some reports, but our data show them to be selective feeders. Surprisingly absent were the very common mud crabs and shore crabs. Also surprisingly low in consumption were fish.

The one dogfish obtained was a young 82 cm long female, ovaries were gravid, stomach was empty.

Bat stingray data:
23 specimens, Oct. of 1967, Feb., March, April, May and June of 1968

Measurements refer to maximum width in cm, tip to tip of pectoral fins.
of 16 females: all 6 less than 100 cm wide, were immature, range 42-83 cm
all 10 more than 100 cm wide were gravid, range 100-117 cm
of 7 males, range was 64-94 cm wide
of 23 stomachs, none were empty

Total contents: 3734 cc, average 162.3 cc

principal foods: red ghost shrimp in 3 stomachs
blue ghost shrimp in 1 stomach
cancer crabs in 4 stomachs
unidentified crustaceans in 2 additional stomachs
worms occurred in 4 stomachs
1 bat had 3 species of worms
1 bat had 50 cc of a large offshore _Neanthes brandti_
1 bat had 210 cc of a mud worm, _Notomastus tenuis_
1 bat had 3 tapeworms in its stomach
Washington clam siphons in 5 stomachs
(1 of these with 17 siphons, 710 cc)
gaper clam siphons in 6 stomachs
(1 of these with 5 siphons, 490 cc)
other clams in 11 stomachs
sand and rocks, very small amounts, in 5 stomachs

Comments:

The principal foods are clams, followed by crustaceans and worms as second choice. Remarkably little sand, rocks, algae or shells were noted. The shells perhaps are rapidly dissolved by the stomach acids. Bats also appear to be selective feeders.

The bat stingray spends more than 75% of their time on the bottom or foraging just above the bottom. Leopard sharks spend about 25% of their time on the bottom. (Russo and Herald, 1968)

We are unable to explain the high frequency of occurrence of the ghost shrimps in the stomachs of the sharks. Ghost shrimp are supposed to stay within their mud-sand burrows. The bats could dig them up, but how do the sharks get them? We have noted only a few ghost shrimp out on the surface.

We considered the possibility of their being active at night. However, 6 of us in two boats (at night) with a variety of surface and below-surface lights (both white and ultra violet) saw no ghost shrimp. We saw many mud crabs - active, but no ghost shrimp or worm activity. Many small fish (sculpins, perch, smelt and sanddabs) were seen. Several sharks were noted. Is it possible that sharks follow bat stingrays - allowing the bat to dig up the shrimps and clams which the sharks consume after driving (?) the bats away? Unfortunately, the waters of Bolinas Lagoon are too turbid to investigate this idea. It remains however, leopard sharks feed principally on crustaceans and molluscs that normally are 1-3' deep within the sandy mud!

Fish - beny fish

There is a concept that lagoons and estuaries serve as important nursery grounds for the young of many species of marine life.

In this connection we have initiated a number of studies. Students at the College of Marin and San Francisco State College have undertaken studies involving hundreds of man hours.

We selected a location at a drainage creek (McKinnan Gulch) by Leonards Place - on Highway 1, opposite Pickleweed Island. This selection was made after a number of seine hauls at locations throughout the lagoon. The station selected is a main point of convergence of ebb tides and similarly of divergence of the incoming flood tides.

Using a seining net of ¼" mesh, 6' x 35', three seine hauls were made on each collection, one each on the north, west and south sides of a rocky promintory. Fishes were sorted and identified. Typically 5 individuals of each species were placed in 10% formalin. Shortly thereafter, the stomachs were removed. Contents were studied preliminarily at San Francisco State College. Further studies at the California Academy of Sciences carried the identifications as far as their (digested) condition permitted.

Collections for the first two months were made by Mr. Ron Nolan. Thereafter, collections were made by Mr. Craig Hansen of the Bolinas Marin Laboratory.

Nine hundred ninety-five specimens representing 26 species were collected at monthly intervals for a full calendar year, July, 1967 to June, 1968. The data clearly indicate that an enormous number of juvenile fish utilize the lagoon. The greatest periods of use are: (Occurrence of at least 10 individuals for 2 or more months)

Topsmelt, Atherinopsis affinis: (Jan.?) Feb. - Dec.
Jacksmelt, Atherinopsis californiensis: Sept. - Dec.
Speckled sanddab, Citharichthys stigmaeus: Apr. - Dec.
Herring, Clupea pallasi: March - May
Shiner perch, Cymatogaster aggregata: May - Oct.
Surfsmelt, Hypomesus pretiosus: Feb. - April ?
Pacific Staghorn sculpin, Leptocottus armatus: Feb.-July (probably year round, especially juveniles)
Dwarf perch, Micrometrus minimus: June-December
English sole, Parophrys vetulus: April - Aug.
Cabezon, Scorpaenichthys marmoratus: May (also Apr. - Oct.)

The studies of College of Marin students, T. Stetson and G. Griffin, have both extended and confirmed our studies. Both of these reports extended our knowledge of the areas of the lagoon that are utilized by juveniles.

Mr. Ken Adams, a candidate for the masters degree at San Francisco State College, is conducting a year-long study of the flats between Stinson sand spit and Highway 1 and between Seadrift Bridge and Pickleweed Island. His data will extend our knowledge of the use of tidal flats by juvenile fish. Mr. Adams, in a preliminary progress report, states:

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> "Differentiating between larval, juveniles, and adult forms is quite subjective at present but I would hope to establish a rough rule of thumb in designating those organisms larval which are, in the natural state, nearly transparent and obviously not having the same degree of morphological development as adults.
>
> "Juvenile forms are designatedas those organisms which are one-half or less than the sizes given for the adult of the species

| SPECIES | ADULT SIZE | REFERENCE* |
|---|---|---|
| *Hypomesus pretiosus* | to 10" | 1 |
| *Clupea pallasi* | to 13" | 1 |
| *Engraulis mordax* | to 7" | 1 |
| *Atherinops affinis* | to 12" | 2 |
| *Leptocottus armatus* | to 12" | 2 |
| *Scorpaenichthys marmoratus* | to 2'6" | 1 |
| *Clevelandia ios* | to 2" | 1 |
| *Pholis ornata* | to 12" | 1 |
| *Syngnathus griseolineatus* | to 13" | 1 |
| *Cymatogaster aggregata* | to 6" | 2 |
| *Micrometrus minimus* | to 6¼" | 2 |
| *Cithaichthys sordidus* sp? | to 13 3/4" | 1 |
| *Platichthys stellatus* | to 3' | 1 |
| *Parophrys vetulus* | to 22½" | 1 |
| *Roccus saxitilis* | to 4' | 2 |
| *Sebastodes auriculatus* | to 21½" | 2 |
| *Myliobatis californicus* | to 4' wide | 2 |
| *Triakis semifasciata* | to 7' | 2 |
| *Acanthogobius flavimanus* | (presumably to 8") | |

* 1. Clemens & Wilby 1961
*Fishes of the Pacific Coast of Canada*
Bulletin 68, Fisheries Research Board of Canada
2. Miller, Gotshall & Nitsos 1965
*A Field Guide to Some Common Ocean Sport Fishes of California*
California Department of Fish & Game"

- - - - - - - - - - - -

Later results have indicated that the channel behind (north of) Kent Island, and the shallow flats behind (north of) Stinson Beach would have been better locations in terms of numbers of species of fish and the abundance of their occurrence. Other observations by us have shown a very general distribution of small fish throughout the lagoon - probably by tidal action as well as their own mobility. Many juveniles are left behind on the mud flats and sand flats as the tides recede. It is on these fish that most herons and egrets feed.

Fish - Pine Gulch Creek

Pine Gulch Creek, draining the west and north areas of the lagoon watershed, is the only permanent stream entering the lagoon. Mr. P. Tupas and Mr. J. Smith of the College of Marin have made an initial study of the fish inhabiting this creek from March to May, 1968.

Mr. Edward Fineman, a candidate for the masters degree at San Francisco State College has completed 10 months of a year's study on the fish of the creek.

These two studies support each other in their findings. Not considering the fresh water fish (*Cottus asper*, *Gasterosteus aculeatus*, and *Hesperoleucus venustus*, all of which utilize this stream) we find that:

*Atherinopsis affinis*, topsmelt, is a rare inhabitant
*Clevelandia ios*, arrow goby " " "
*Hypomesus pretiosus*, surf smelt, is an uncommon inhabitant
*Leptocottus armatus*, staghorn sculpin, is very common from January to May
*Roccus saxatilis*, striped bass, is an occasional inhabitant in deep pools, May - August
*Salmo gairdneri*, rainbow trout, is uncommon January-April, but common May-December

In the case of the trout we think that there is an annual crop, hatched from eggs, that appear in spring but leave for the ocean during the winter rains. The adult rainbow (or steelhead) apparently enter the stream for spawning during the winter months.

Fish - juveniles, stomach contents, McKinnan Gulch station

Stomach contents of juvenile fish, commonly collected for over a period of 2 or more months were analyzed. Since these specimens are juvenile and their stomachs were so small, no attempt was made to measure the volume of the contents or of the species represented. Numbers refer to occurrences in the stomach. A selection of our data relative to the most important (abundant) juveniles is presented.

JUVENILE STOMACH CONTENTS

|  | # | empty | Cancer & other crabs | Amphi-pods | shrimp | unident. pieces of crustaceans | Poly-chaetes | Nereids | Misc. worms | Para-sitic worms | clams | algae | fish | Unident. food partic. | sand rocks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atherinopsis affinis, topsmelt | 45 | 12 |  | 4 |  | 6 |  |  | 2 | 1 |  | 7 |  | 10 | 9 |
| Atherinopsis californiensis, Jack smelt | 6 | 3 |  |  |  | 2 |  |  |  |  |  | 2 | 1 |  |  |
| Citharichthys stigmaeus, speckled sanddab | 50 | 18 | 3 | 2 | 2 | 14 | 2 | 2 | 1 |  | 12 | 7 |  | 3 |  |
| Cymatogaster aggregata, shiner perch | 34 | 24 |  |  |  | 2 |  |  |  |  |  | 1 |  | 5 |  |
| Hypomesus pretiosus, surf smelt | 13 | 9 |  |  |  | 3 |  |  |  |  |  |  |  | 2 |  |
| Leptocottus armatus, staghorn sculpin | 78 | 21 | 15 | 7 | 4 | 10 | 8 | 2 | 5 | 2 | 3 | 5 | 2 | 12 | 7 |
| Micrometrus minimus, dwarf perch | 26 | 8 |  | 3 | 1 | 6 | 1 |  | 1 |  |  | 8 | 2 | 5 |  |
| Parophrys vetulus, English sole | 57 | 19 |  | 4 | 1 | 19 | 8 |  | 1 | 4 | 4 | 2 | 1 | 5 | 8 |
| Scorpaenichthys marmoratus, cabezon | 23 | 3 | 1 | 2 | 2 | 5 | 3 |  |  |  | 1 | 3 | 3 | 3 | 5* |

* 1 cabezon had 7, another 6 pebbles in their stomachs

Fish - nursery grounds

On the basis of the fish studies we may say:

Pine Gulch Creek is an important element for 3 very important game and rough fish during the months of January to May. In the summer months it serves to produce hundreds of fresh water fish - roaches and sticklebacks - which are involved in food cycles yet to be worked out for this area. We have noted numbers of black crowned night herons and belted kingfishers feeding in this area as well as numerous garter snakes - the latter eaten by the great blue heron.

The sand flats and mud flats are important as nursery grounds for the juveniles of 10 species of fish which are common to abundant during every month of the year except January. These same flats support large crops of algae, and worms, amphipods, crustaceans and clams. Previous pages have shown the detailed information demonstrating the critical importance of these areas of high production.

The flats of low invertebrate food production - such as most of the offshore shallows of the north end of the lagoon - serve as entrapment areas for larval fish, which in turn are consumed by the herons, egrets, kingfishers, gulls and other birds.

No part of the lagoon is without important food and wildlife values.

Russo, R. A. & E. S. Herald 1968 The 1967 Shark Kill in San Francisco Bay, California Fish & Game Vol. 54, No. 3, p. 215-216.

Birds - Shorebirds and other marine birds

The following data on shorebirds and gamebirds which utilize the lagoon from winter through spring has been contributed through the very devoted efforts of a group of Audubon Society and Audubon Canyon Ranch members under the direction of Dr. Richard Doutt, Professor of Biological Control, Universsity of California, Berkeley. Assisting him were: Craig Hansen, Tom Harris, Nello Kearney, Helen Pratt, John Ralph, Alice Williams and C. W. Zumwalt.

Census of avifauna - Bolinas Lagoon - November 28, 1967

Weather clear, sunny, few scattered clouds, very gentle breeze from northwest. Temperature about 60 F. Census started at 9:00 a.m. with tide high (5.8) ebbing to -0.1 about 3:00 p.m.

Count made by Pratt, Zumwalt, Harris, Kearney, Ralph, Hansen and Doutt.

This group began the census at the marsh near Dipsea Inn, Stinson Beach, and together counted the birds systematically in seven arbitrarily delimited areas along highway #1. These areas were contiguous sequentially on their north and south borders, they were bounded on the east by the highway and then extended seaward to the effective range of the telescopes. The group had binoculars and 5 telescopes. One count was made southward from the Bolinas highway. Then counts were made from four areas on Kent Island. The last count was made just prior to 3:00 p.m. from Kent Island with the tide at about its lowest point.

Only the birds associated with the ecology of the lagoon were counted (so such things as bushtits and Bewick's wrens along the road and soaring turkey vultures were not included). By this procedure a total of 44 species were recorded and 8,190 individuals were counted.

This is an indication of the populations, not an absolute count. It probably is about 80% of the total number of individuals present. The species count is probably very close although we could have missed two or three.

Comments: The gull count is more accurate than that made on sandpipers because of the conspicuous nature of the gulls. The sandpiper population may well have been double the recorded figure. We saw no color-marked (marked by Point Reyes Bird Observatory) shore birds. No godwits nor turnstones were seen until we were on Kent Island. All the shorebirds were more concentrated on the east side of the island and adjacent area than elsewhere in the lagoon. Savannah sparrows were seen only on Kent Island. The black crowned night herons were roosting in the cypress and monterey pine trees near the Bolinas dock. The absence of common egrets, Heerman's gulls, Brant, avocets and phalaropes is worth mentioning.

Census of birds - Bolinas Lagoon - December 19, 1967

Counts made by Pratt, Williams, Zumwalt, Harris and Doutt

Weather clear, sunny; light breeze from northwest; temperature in high fifties.

Count begun at 9:10 am. with tide flooding, nearly at its peak. Tide was high during most of count forcing shorebirds into Salicornia. This made them difficult to see and probably reduced the counts.

The great blue herons were mostly seen on high ground on Kent Island. Three individuals were in the oak trees near the house at Audubon Canyon Ranch. None were in the immediate vicinity of the heronry. The snipe were in the pasture in front of the house at Audubon Canyon Ranch. The two american egrets were seen at some distance on the marshland north of Kent Island while looking from the island northward toward the Bolinas-Olema Road. The short eared owl was clearly seen and regurgitated a pellet containing mouse remains while under observation on Kent Island. A flight of what appeared to be 12 longbilled curlew in "V" formation was seen at a distance but these birds are not included for lack of confirmation.

The December 19 census tallied 48 species totaling 7,133 individuals. The total species counts for the two censuses are now 53 different species associated with the lagoon environment.

Census of birds - Bolinas Lagoon - January 23, 1968
(This count does not include a census from Kent Island)

Census made by Williams, Zumwalt, Harris and Doutt.

Weather clear, sunny, wind from east increasing during period of census. Temperature mid-fifties. Tide low - ebbing at start of count 0900, was still ebbing with considerable mud exposed at close of count 1330 hours.

We did not have access to Kent Island so counts are those made in regular areas along highway #1, Bolinas-Olema road, and from road near Marine Station, Bolinas. This lowers total number of individuals and explains absence of some species such as savannah sparrows. Six species not recorded on the two earlier counts are included. Thus in our 3 censuses the accumulated total is 59 different species for the lagoon area. Certain species such as song sparrows and black phoebe are marginal for the habitat. They are seen in the Typha south of the causeway to Seadrift. A total of 43 species and 7,099 individuals were counted.

The number of Avocets counted this time is remarkable. They were widely distributed from south of the Seadrift causeway to the Bolinas-Olema road. The widgeon and cinnamon teal were near the willow patches along the Bolinas-Olema road. The high count of long-billed curlew suggests that the "V" formation of 12 seen on December 19 was an accurate identification. The heronry at Audubon Canyon Ranch was visited but no herons were in the area. Nesting activity for the herons is expected to begin within the next 30 days.

Census - February 12, 1968.

Counts by Tom Harris, Sarah Harris, C. M. Zumwalt, Helen Pratt, Alice Williams and R. Doutt.

Tide very high at beginning of count, 0900, ebbing throughout count period. Weather sunny, warm, no wind. Could not operate boat to Kent Island, so that area not included in this count. This count is therefore comparable to January 23 census in areas covered.

There is a noticeable drop in February in total bird counts as well as in species. The shoveler was a single female, but it adds another species to the accumulated total. The changes taking place are of considerable interest. On February 8, 35 great blue herons arrived at the Audubon Canyon Ranch heronry. By February 10 some nesting activity was underway and more birds had arrived to increase the total to 55. On February 12 two Common Egrets had arrived at the heronry and 3 additional birds were in the lagoon.

The drop in total individuals in the lagoon census is attributed to migratory activity. The avocets dropped in numbers, none of the remaining birds are in breeding plumage although this is beginning to show in avocets around San Francisco bay proper.

| Census for: | XI/28/67 | XII/19/67 | I/23/68* | II/12/68* |
|---|---|---|---|---|
| Total individuals | 8190 | 7133 | 7099 | 2777 |
| Total species | 44 | 48 | 43 | 38 |
| Accumulated species | 44 | 53 | 59 | 63 |
| Loon, sp. | - | - | - | 2 |
| " common | - | 1 | - | - |
| " red throated | - | 2 | - | - |
| Grebe, horned | 7 | 13 | 16 | 16 |
| " eared | 7 | 5 | 2 | 4 |
| " western | 4 | 2 | - | 10 |
| " pied billed | 1 | - | - | - |
| Pelican, brown | 9 | 8 | 1 | - |
| Cormorant, Dbl Cr. | 13 | 14 | 11 | 25 |
| Heron, Great blue | 15 | 23 | 10 | 55 |
| Egret, Common | - | 2 | - | 5 |
| " Snowy | 10 | 8 | 6 | 15 |
| Heron, Bl Cr Nt. | 9 | 23 | 12 | 21 |
| Duck, pintail | 90 | 4 | 53 | 4 |
| Teal, Cinnamon | - | - | 2 | - |
| American Widgeon | - | - | 12 | - |
| Duck, Redhead | - | 1 | - | - |
| Shoveler | - | - | - | 1 |
| Canvasback | 20 | 13 | 32 | 4 |
| Scaup (spp) | 50 | 408 | 153 | 228 |
| Goldeneye, common | 55 | 67 | 15 | 26 |
| " Barrows | - | 1 | - | - |
| Bufflehead | 200 | 104 | 50 | 76 |
| Scoter, Wht wing | 391 | 2 | 13 | 4 |

* Bird counts do not include those of Kent Island; totals should be raised some 1000-1500 to make the last 2 months comparable to the first 2 months of the survey. (JFG)

| | XI/28/67 | XII/19/67 | I/23/68 | II/12/68 |
|---|---|---|---|---|
| Scoter, surf | 134 | 44 | 54 | 29 |
| " common | - | - | 9 | - |
| Duck, ruddy | 1755 | 1120 | 789 | 1161 |
| Merganser, hooded | 1 | 1 | - | - |
| " redbreasted | 8 | 6 | 4 | 2 |
| Osprey | 1 | - | - | - |
| Coot | 418 | 771 | 444 | 486 |
| Plover, snowy | 13 | - | - | - |
| Killdeer | 5 | 23 | 16 | 20 |
| Plover, Blk Bellied | 19 | 19 | 57 | 2 |
| Turnstone, blk | 7 | 1 | 2 | - |
| " ruddy | - | - | 2 | - |
| Snipe, common | - | 2 | - | - |
| Curlew, long billed | 16 | 15 | 22 | 2 |
| Sandpiper, spotted | 1 | 1 | - | 1 |
| Willett | 219 | 166 | 331 | 53 |
| Yellowlegs, greater | 5 | 9 | 1 | 2 |
| Sandpiper spp.* | 2665 | 2898 | 3378 | 110 |
| Godwit, marbled | 32 | 27 | 90 | - |
| Sanderling | 260 | 211 | 174 | 20 |
| Avocet | - | - | 105 | 9 |
| Gulls spp. | 1714 | 1061 | 1217 | 191 |
| includes Western | 14 | 2 | 2 | 2 |
| herring | 53 | 12 | 8 | 42 |
| California | - | 2 | 1 | - |
| ring billed | 8 | 2 | 48 | 60 |
| mew | 596 | 1042 | 744 | 64 |
| Bonapartes | 4 | 1 | 1 | - |
| Owl, short eared | - | 1 | - | - |
| Kingfisher, belted | 4 | 7 | 5 | 3 |
| Phoebe, black | - | - | 1 | 4 |
| Blackbirds, brewers | - | 54 | - | - |
| " redwinged | 3 | - | 8 | 10 |
| Sparrow, savannah | 20 | 6 | 2 | - |
| " song | 7 | 6 | 2 | 7 |
| Yellowthroat | 2 | - | - | - |

(63 total species identified)

* Dunlin, Dowitcher and Western sandpiper

- - - - - -

Following this work, the group, now expanded, has initiated a year-long study of the bird life of the lagoon! It is indeed unusual and especially rewarding to find such endeavor and such competence among a group of "volunteers."

The above listing of birds is not a check list of the birds likely to be seen at the lagoon. For such a check list, see the A.O.U. list published by the Marin Audubon Society.

According to Reinecker (1965), bandings have indicated that California winters over 75% of all birds in the Pacific flyway. Studies by the Department of Fish and Game of California have shown that 60-90% of the shorebirds of the Pacific Coast overwinter in the San Francisco Bay area.

It is obvious therefore that if this very large segment of our bird life is to persist, that we must be concerned with the preservation of significant areas for their winter habitat. It so happens that these selfsame areas are the same ones that are important for our estuarine (and to some considerable extent) coastal invertebrate and vertebrate marine animals - from worms through shrimp, crabs and clams to all of the fishes, and even the seals, sea lions and whales.

In this case at least, habitat preservation is not for a single use. We have demonstrated a host of animals - both with and without vertebral backbones that are becoming more and more dependent upon our interest and protection for their survival. The time and interest shown by the many cooperators listed in this and in the previous sections attest to the growing awareness of the importance of and the necessity of both habitat preservation and (where lacking) of habitat reconstruction.

Birds - stomach contents of marine birds

Very few studies have been published on shorebird or wildfowl stomach contents. Federal and state regulations regarding shooting permits as well as the grinding of the contents in the gizzard and the rapid disintegration of the stomach contents have contributed to our lack of information and the difficulty of improving on it.

Reeder (1951) and Recher (1964) have some data on shorebird stomachs. Kingsley (1966) has made observations on feeding habits. Zumwalt (personal communication) has reported on observations through telescopes mounted nearby nests on the appearance of food matter as it is regurgitated into the stomachs of the nestlings of great blue herons and egrets.

On the basis of these references and observations we may conclude that:

Herens and egrets feed primarily on juvenile fishes trapped or delayed on flats as the tide recedes. Both birds, especially the herons forage in adjacent fields and will eat apparently any animal - snakes, rodents, large insects, crayfish, etc. Other invertebrates are minor food items.

Plovers, sandpipers and sanderlings that typically feed over the pickleweed (*Salicornia*) marshes feed primarily on insects (larvae and pupae) - especially (*Ephydra*) flies and occasionally beetles of the families Tenebrionidae, Carabidae and Buprestidae.

Phalaropes, stilts, and avocets may also feed primarily on insects when abundant in the marshes.

Willets feed primarily on worms and clams. Recher (1964) reports observing one willet that consumed over 20 clams (3/4 to 1½" in size) in a 10-minute period.

Plovers, sanderlings and sandpipers (Reeder 1951) in southern California feed 75-80% on the sand crab, Emerita analoga.

The tiny clam, Gemma gemma, makes up a significant percentage of the food contents of the: black bellied plover (12.7%, avocet (52%), knot (55.3%), and willet (46.1%), Recher (1964).

Worms make up a significant percentage of the food contents of the: ringed plover (94.5%), black bellied plover (16.4%), avocet (16.0%), dunlin (70.0%) and marbled godwit (76.0%), Recher (1964).

Amphipod and ostracods (small crustaceans) make up a significant percentage of the food contents of the: avocet (28.0%), dowitcher (24.0%), least sandpiper (31.6%), and dunlin (14.7%), Recher (1964).

Snails and clams make up a significant percentage of the food contents of the: avocet (24.0%), dowitcher (10.5%), least sandpiper (10.5%), western sandpiper (11.4%), marbled godwit (9.1%), and willet (13.9%), Recher (1964).

Professor Howard Cogswell has stated (personal communication) that shorebirds average per acre is:

Oakland-Alameda: 20 birds/acre
Hayward and South San Francisco Bay: 16 birds/acre

Proctor (1968) has shown that shorebirds may carry and deposit undigested seeds for distances of several thousand miles. Of course many of these seeds would fail to produce persisting vegetation in alien areas. However, the shorebirds have the ability to seed areas with selected and preferred food plants.

Harbor seal

Harbor seals, Phoca vitulina, can be seen in the channels from the mouth of the lagoon and southeast along Stinson Beach sand spit, around Pickleweed Island and then north to the big duck blind offshore of the Audubon Canyon Ranch.

There is a "pad", their spot on the sandy beach, near the southeast corner of Kent Island. Mr. D. Harris of College of Marin (1968) has observed that the channel immediately in front of the pad deepens very quickly to about 14'. This channel is 100 or more feet wide at this point. The pad is on an open sandy beach with the nearest (marsh) vegetation about 125' away. Even though the pad is on Kent Island which frequently has many human and dog visitors, the seals can detect any approaching object from a considerable and safe distance. Harris believes that the steep channel bank at this point is the major reason for the selection by the seals of this location. They are not seen on land elsewhere. They are seen frequently in the mouth of the lagoon.

We have noted from 16-34 seals on the pad during the summer months of 1967 and 1968. Mr. Craig Hansen of the Bolinas Marine Laboratory estimates their number to be between 37-40. He also notes that during the winter the pad is used by a smaller number - perhaps 6 to 12.

We noted two young pups early this summer. Mr. Siegel made an observation that I was fortunate to see with him on a later date. The young pups are very "inquisitive and fearless." When a pup is approached by a boat, it swims toward the boat. The adult (mother ?) comes up beneath the pup who then clasps its (mother's) neck with its front flippers and the pair swim away from the boat. The pup lying on the back of the adult. The adult turns its head back around toward the pup for several seconds. The entire event is accomplished quickly. This cameo scene stimulates one to make several anthropomorphic interpretations. We permit ourselves one. It does appear that the adult intercepts the pup from danger, carries it away and if there is no lecture to the young, at least there is a long (scolding ?) look.

Ingles (1965) states that mating occurs in September, that this seal is polygamous (no harems) and that the young are born in early spring. The food consists of fish, molluscs, and crustaceans.

Harbor seals snore - loudly!

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Ingles, L. G. 1965 Mammals of the Pacific States, Stanford University Press.

Proctor, V. W. 1968 Long-Distance Dispersal of Seeds by Retention in Digestive Tract of Birds, Science, Vol. 160, p. 321-322.

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## Marine plants

In plotting the vegetation of the mud flats and sand flats we are indebted to a number of students of the College of Marin, Bolinas Marine Laboratory, especially K. C. Mannix. Their studies have assisted us in addition to our own field investigations.

Microscopic plants called mud flat diatoms are frequent inhabitors of mud flats and sand flats. These plants are either single-celled plants or grow in short chains (filaments). Some of the diatoms are large enough to see with the naked eye.

Diatoms live within the upper centimeter of the bottom substrate. When the tide is in, the diatoms migrate downward. When the tide is out, they migrate to the surface. When abundant, diatoms may give the surface a slick, rather slimy, green or olive brown colored appearance. In waters less than 2 fathoms deep (12'), these diatoms and the other mud flat algae (Ulva, Enteromorpha) are more important than the suspended plankton in producing carbohydrate. Since nearly all of this lagoon is less than 1 fathom (6') at high tide, we decided to place our emphasis concerning productivity studies on the mud flat diatoms and other algae rather than on the plankton.

Several preliminary plankton studies have been undertaken by students at the Bolinas Marine Laboratory from College of Marin. We have not covered this phase of the lagoon ecology for the reasons given above.

Maidens Hair, a red alga (Gracilaria Sjoestedtii) is occasionally found in the deeper channels of the lagoon - particularly toward the northern end. There are a few large beds of this alga in the flats southwest of Audubon Canyon Ranch.

The green grass algae, 3 species of Enteromorpha, (E. clathrata, E. compressa, E. intestinalis) during late spring and summer are abundant over the shallow muddy flats. E. intestinalis is the most widely distributed. It covers large sections of the shallows at the north end of the lagoon as well as west of the Seadrift bridge behind Stinson Beach. E. compressa is found attached to rocks near fresh water seepage, i.e., at mouths of creeks at the north end of the lagoon.

Sea lettuce, three species of Ulva, (U. expansa and U. Linza and U. Lactuca) are the most widespread of the algae. U. expansa, looking much like large sheets of limp lettuce, covers acres of the lower mud and sand flats.

The species of Enteromorpha, Ulva and the mud flat diatoms are the most important plants in the lagoon for four reasons. One, they engage in photosynthesis - the production of sugars by the green pigment chlorophyll in sunlight, and thus are at the base of all life food cycles. Two, the green algae secrete up to 10% of their daily carbohydrate production into the water. Thus, the water is enriched by these plants. Three, the plants are consumed by a large number of animals - worms, crustaceans, fish, birds, etc.). On death, the plants become part of the plant detritus that enriches the floor of the lagoon. Most worms, ghost shrimp, clams and many others live primarily on this detritus. Four, the surfaces of the green algae support a huge population of diatoms and both microscopic and macroscopic animals. That is, a sheet of Ulva represents not only the green alga itself but an enormous community of life. This community is one that is associated with surfaces. It is now possible to buy Japanese plastic algal sheets to suspend in estuarine or lagoon waters. The surface itself provides the necessary substrate - above the bottom silt and sand. One can demonstrate this community by seizing a handful of algae and sloshing it up and down in a bucket of water to dislodge the animal life from the surfaces. Each large crustacean or worm then seen in the bucket undoubtedly represents hosts of others too small to be seen.

For the above reasons, then, the flats with their large algal populations are important elements in the ecology of the lagoon.

Eelgrass, Zostera marina, is present in so far as we can determine in only one location - in the Bolinas Channel, close by the large cement retaining wall. Despite earlier attempts by the Department of Fish and Game to establish eelgrass in other areas of the lagoon, we have not found any other locations of eelgrass within the lagoon.

As described previously, the algal populations reach high levels of population growths in lagoons not matched elsewhere per unit area. These plant populations in turn support the growth of innumerable animals. That some of the animals are predaceous and some are parasitic is beside the point. The net result of all of this biological activity is that Bolinas Lagoon supports an enormous quantity of plants and animals.

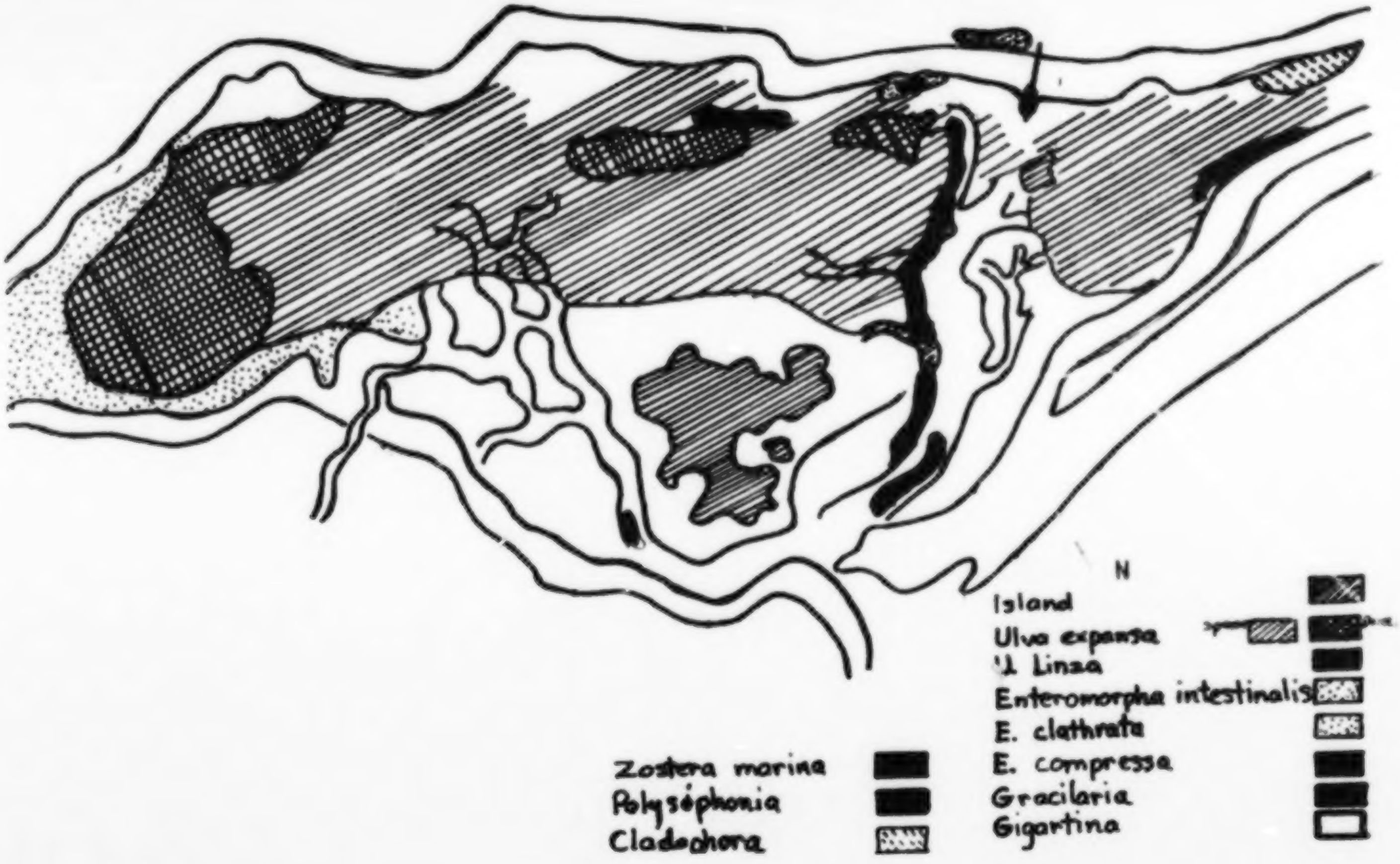
The following 2 charts are reproduced from the B. M. L. report of K. C. Mannix: "An Algae Survey of Bolinas Lagoon," 1967. This study was performed under the direction of Mr. A. Molina of College of Marin.

ALGAE DISTRIBUTION

| | East End | South Channel | Main Channel | Wharf "E" | Creek | Small Lagoon | West End |
|---|---|---|---|---|---|---|---|
| U. expansa | *** | | * | *** | | ** | *** |
| U. Linza | | | | * | | | |
| E. intestinalis | *** | | | * | | * | |
| E. clathrata | *** | | | | | ** | |
| E. compressa | | | | | *** | | |
| Gracilaria | | | ** | ** | | * | ** |
| Gigartina | | | | * | | | |
| Zostera | | * | | | | | |
| Polysophonia | | | | * | | | |
| Cladophora | | | | | | | * |

Dense***
Abundant**
Sparse*

Bolinas Lagoon Low Tide


N
Island
Ulva expansa
U. Linza
Enteromorpha intestinalis
E. clathrata
E. compressa
Gracilaria
Gigartina
Zostera marina
Polysiphonia
Cladophora

## Productivity of Mud flat algae.

Mr. Stephen Siegel received his masters degree from San Francisco State College for devising methods for measuring the rates of carbohydrate of mud flat diatoms and *Ulva*. Mr. Siegel used $C^{14}$ labelled sodium bicarbonate to measure the rate of carbon incorporation = carbon synthesis = rate of photosynthesis. Although the = signs hide an involved series of field and laboratory methods, he was able to demonstrate their approximate rates of photosynthesis. Both the diatoms and *Ulva expansa* are extremely active producers of carbohydrates - the energy that fuels the biology of the lagoon. The following pages in this section were submitted by Mr. Siegel.

## CARBON ASSIMILATION DATA*

### Estimation of carbon incorporation rates.

The rate at which carbon, in the form of $CO_2$ or, more probably, $HCO_3$, is assimilated by an actively photosynthesizing algal thallus can be determined by supplying to the algae a known amount of carbon-14 in the form of $NaHC^{*}O_3$. The plant incorporates this labelled carbon, as well as the carbon-12 normally in the seawater. After allowing the algae to incorporate this radiocarbon for a carefully measured period of time, the algae is killed and dried. Then, by using a Geiger counter, the amount of radioactivity that the algae acquired can be measured. By measuring the temperature, salinity and pH of the seawater, it is possible to calculate, from tables given by Harvey (1960), the amount of $C^{12}$ present in the seawater. As the amount of $C^{14}$ added is known with some accuracy, we may set up the ratio $\frac{C^{12}}{C^{14}}$. After determining how much $C^{14}$ has been incorporated, and after making the corrections for the difference in rate at which $C^{12}$ and $C^{14}$ are incorporated, it is only necessary to multiply the value for the $C^{14}$ incorporation by the factor $C^{12}:C^{14}$. This will then give the value for the *total* $(C^{12} + C^{14})$ carbon incorporation.

Since the surface area of the samples are known, the carbon incorporation values can be expressed on a square inch, square meter, acre, or any other areal basis.

All the tests upon which this data is based were conducted for 3 hours, in the middle of the day. In order to transpose this data so that it gives the amount of carbon incorporated *per day*, and not just per 3 hours, it is necessary to make two assumptions, both of which are known to be grossly inaccurate. First, we must assume that the *rate* of photosynthesis is *the same* during the entire day as it is during the 3 hours of the test. Secondly, we assume that the photoperiod lasts 12 hours each day. Now, to change the 3-hour incorporation data to 12-hour incorporation data, the results of these tests are multiplied by 4. This will give a very crude estimation of carbon incorporation per day, per sample. (It should be emphasised that, while this value is known to be very inaccurate, the values calculated for the 3-hour test are quite accurate, as no unwarranted extrapolations are introduced until we try to convert the data into a daily figure.)

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*This section presents a portion of the methods and data offered in the masters thesis of Mr. Stephen Siegel at San Francisco State College, 1968.

The area of each of the sample pieces of algae is 2.3 $cm^2$. If the data is expressed in $m^2$, acres or hectares, we are assuming a uniform covering of algae over this larger area, and also that the algae is all in the same physiological condition and is photosynthesizing at the same rate. These are highly erroneous assumptions.

Conversions performed on the above data.

The incorporation data is originally expressed in terms of carbon incorporation per 2.3 $cm^2$. This is extrapolated to mg C/ $m^2$. According to Odum (1959), grams per meter, when multiplied by 8.9, will give pounds per acre. This value is then multiplied by 4 to give lbs/acre/day. (Since the values of carbon incorporated are so small, the expression is actually lbs x $10^{-3}$/acre/day.) Steeman-Nielsen and Hansen (1959) found that under ideal conditions, when the photosynthesis:respiration ratio is equivalent to 10, 90% of all assimilated carbon is in excess to the plant's immediate needs and is stored, mainly as carbohydrate. On a 24-hour basis, allowing for the use of stored materials during the night (we must assume that the rate of respiration is the same in the light as in the dark), 45% of all assimilated carbon will be in excess to the plants needs and will represent net productivity. Therefore, the next step is to multiply the value lbs x $10^{-3}$/acre/day by 0.45, to determine net stored carbon.

Harvey (1960) and Hedgepeth (1957) state that the efficiency of utilisation of vegetable matter by plankton and filter-feeders is 70%. That is, for every 100 gm. algae eaten by zooplankton or extracted from the water by filter-feeders, 70% is assimilated into the animal's tissues and 30% is lost through the gut. Therefore, 70% of the storage products of the algae (net production) can be considered to be available for the forming of animal tissue, if we assume 100% harvest of the algae and the secreted algal products. This is a measure of the fate of the carbon incorporated, not necessarily the products of photosynthesis. Smith (1943) has estimated that at 20°C, 98% of the assimilated carbon ends up as carbohydrates. This figure is considered by Rabinowitch (in his treatise on photosynthesis, 1957) to be accurate under ideal conditions.

Elemental carbon is considered to form about 20% (Weiss, 1965), by weight, of animal tissue. Therefore, if we know the amount of carbon that ultimately gets eaten by an animal, we can multiply this value by 5 to get a rough approximation of the total weight of animal soft tissue represented by this amount of carbon.

To give an example of these calculations let us assume that 100 gms of carbon have been assimilated by an algae, and that the entire plant is consumed by animals.

100 gm assimilated (measured by tracing, and the $C^{12}:C^{14}$ factor)
45 gm stored (excess beyond plant's respiratory needs)
31.5 gm assimilated by animals (45 x 0.70)
157.5 gm animal soft tissue produced (31.5 x 5)

Therefore, under ideal conditions, if all our assumptions are correct, 100 gms. carbon assimilated from the water can produce 158 gms. animal tissue. It is probable that this figure is, in reality, inaccurate by at least 500 - 1,000%, or more.

*Addendum*. Harvey (1960), gives the following figures:

100 gm vegetable matter assimilated yields:

70 gm short-lived herbaceous zooplankton
11 gm (6-7% of 70 gm) pelagic fish feeding on zooplankton
1 gm (6-10% of 11 gm) demersal fish feeding on well-grown bivalves

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**References:**

Harvey, H. W. (1960) The Chemistry and Fertility of sea water
Hedgepeth, Joel (1957). p. 38ff in Treatise on marine ecology and Paleontology
Odum, E. (1959) Fundamentals of Ecology, 2nd ed. (p. 70)
Smith, J. H. C. (1943) *Plant Physiology* 18:207.
Steeman Nielsen, E. and V. Kr. Hansen (1959). Measurements of the $C^{14}$ technique of the respiration rates in natural populations of Phytoplankton. *Deep-Sea Research* 5:222-233.

**Sampling method:**

The sampling method was designed to provide data on the rates of photosynthesis of living *Ulva* and diatoms. Consequently, in order to introduce both positive sampling of selected substrate and to gain some concept of geographic (spatial) variation we:

employed a #10 cork borer to make disc cuts in sheets of *Ulva* and to cut "plugs", 1-3 mm thick of the surface diatoms on mud and sand. The discs and plugs had an area of 2.7 sq. cm.

5 sheets of *Ulva* were selected from a 10 meter transect. One plug was taken from each blade - thallus - of algae and tested separately.

5 plugs of mud flat diatoms were taken within a 10 m transect. Each plug was tested separately. We avoided areas of varves (algal mats) and translucent fungul appearing areas.

The method was biased in that it selected those bottom areas containing only *Ulva* or mud flat diatoms. It was random in that we utilized 5 samples of each category over a 10 m area.

## CONVERSION OF CARBON INCORPORATED IN PHOTOSYNTHESIS TO ANIMAL TISSUE

| Station* | Date 1968 | mg/m$^2$ | x8.9 lbs.x $10^{-3}$/acre/ 3 hrs. | x4=lbs.x $10^{-3}$ per acre/day | x.45 C lbs. x$10^{-3}$/acre /day | x.70=assimilable C lbs x$10^{-3}$/acre/day | x5=animal tissue lbs.x$10^{-3}$/acre/ day | animal tissue/ hectare per day lbs.x$10^{-3}$ |
|---|---|---|---|---|---|---|---|---|
| I | 1 Mar. | 6.4x$10^{-2}$ | .57 | 2.28 | 1.03 | .72 | 3.6 | 8.9 |
| II | " | 6.8x$10^{-1}$ | 6.1 | 24.4 | 11.0 | 7.7 | 38.5 | 95.1 |
| III | " | 7.5x$10^{-1}$ | 6.7 | 26.8 | 12.1 | 8.4 | 42.0 | 104 |
| IV | " | 5.5x$10^{-2}$ | .49 | 1.96 | 0.88 | .62 | 3.1 | 7.7 |
| V | " | 1.6x$10^{-1}$ | 1.4 | 5.6 | 2.5 | 1.8 | 9.0 | 22.2 |
| I | 10 Mar. | 6.8x$10^{-1}$ | 6.05 | 24.2 | 10.9 | 7.6 | 38.0 | 94.0 |
| II | " | 6.8x$10^{-1}$ | 6.05 | 24.2 | 10.9 | 7.6 | 38.0 | 94.0 |
| III | " | 6.1x$10^{-1}$ | 5.43 | 21.7 | 9.8 | 6.9 | 34.5 | 85.2 |
| IV | " | 1.7x$10^{-1}$ | 1.51 | 6.04 | 2.7 | 1.9 | 9.5 | 23.4 |
| V | " | 9.6x$10^{-2}$ | .85 | 3.40 | 1.5 | 1.0 | 5.0 | 12.4 |
| I | 14 Apr. | 4.0 | 35.6 | 142. | 63.9 | 44.7 | 223.5 | 552 |
| II | " | 3.6 | 32.0 | 128. | 57.6 | 40.3 | 201.5 | 498 |
| III | " | 4.7 | 41.8 | 167. | 75.2 | 52.6 | 263 | 650 |
| IV | " | 3.7 | 32.9 | 132. | 59.4 | 41.6 | 208 | 514 |
| V | " | 3.3 | 29.4 | 118. | 53.1 | 37.2 | 186 | 460 |
| I | 14 Apr. | 5.1 | 45.4 | 182. | 81.9 | 57.3 | 287 | 709 |
| II | " | 7.9 | 70.3 | 281. | 126.5 | 88.6 | 443 | 1095 |
| III | " | 5.7 | 50.7 | 203. | 91.4 | 64.0 | 320. | 791 |
| IV | " | 2.9 | 25.8 | 103. | 46.4 | 32.5 | 163 | 403 |
| V | " | 4.0 | 35.6 | 142. | 63.9 | 44.7 | 224 | 554 |
| I | 22 Apr. | 6.9 | 61.4 | 246. | 110.7 | 77.5 | 388 | 959 |
| II | " | 5.1 | 45.4 | 182. | 81.9 | 57.3 | 287 | 710 |
| III | " | 4.9 | 43.6 | 174. | 78.3 | 54.8 | 274 | 677 |
| IV | " | 3.5 | 31.2 | 125. | 56.3 | 39.4 | 197 | 487 |
| V | " | 3.2 | 28.5 | 114. | 51.3 | 35.9 | 179 | 442 |
| I | 5 May | 2.7 | 24.0 | 96. | 43.2 | 30.2 | 151 | 373 |
| II | " | 4.9 | 43.6 | 174.4 | 78.3 | 54.8 | 274 | 677 |
| III | " | 3.6 | 32.0 | 128 | 57.6 | 40.3 | 201 | 497 |
| IV | " | 3.3 | 29.4 | 117.6 | 53.1 | 37.2 | 186 | 460 |
| V | " | 3.5 | 31.2 | 124.8 | 56.3 | 39.4 | 197 | 487 |
| I | 12 May | 6.1 | 54.3 | 217. | 97.7 | 68.4 | 342 | 845 |
| II | " | 5.5 | 49.0 | 196. | 88.2 | 61.7 | 308 | 761 |
| III | " | 5.7 | 50.7 | 203. | 91.4 | 64.0 | 320 | 791 |
| IV | " | 4.8 | 42.7 | 171. | 76.9 | 53.8 | 269 | 665 |
| V | " | 4.4 | 39.2 | 157. | 70.7 | 49.5 | 247 | 610 |

* I, II, III = *Ulva* stations; IV and V are mud flat diatom stations

## Summary and Key index species

The following chart presents information regarding our determinations of overall wildlife importance of the bottom life.

Reference to the previous pages on fish stomach contents and bird stomach contents have shown that crustaceans, worms, molluscs and fish are the important foods for fish and birds, and in that order of importance. Such a generalization is lost when one considers a particular species of fish or bird.

Consequently, we have shown both specific details and general tendencies.

We conclude that all forms eventually (in life or death) enrich some biological cycle. If one wishes to know which forms are more obviously important we refer to the previous pages for information on juvenile fishes and the bottom invertebrates.

Thus, when we consider the relation of these life forms to the nature of the bottom and the quality of the water above it, we find that all segments of the lagoon and marsh are valuable.

Major plant production (omitting plankton from this consideration) occursin shallow flats, both muddy sand and sandy mud, but much less so on sandy flats.

Water turbidity increases rapidly as one moves inland.

Organic richness increases rapidly in the same way. The extreme ends of the lagoon - the SE and N ends are very rich with organic matter. Nearly all of this matter is detritus from marine plants (diatoms and algae) except south of the Seadrift bridge where large pieces of semi-decayed fresh water marsh plants (Typha, Scirpus) make up the bulk of the organic matter.

There are major changes in the animal populations between those inhabiting the sandy mud versus the muddy sand bottoms. The quantity and variety of life is much higher in muddy sand bottoms.

Similarly, the use of the muddy sand flats around Kent Island and Pickleweed Island and north of Stinson sand spit by juvenile fish point out a higher wildlife importance of these types of areas.

The greatly simplified chart shows correlations of a number of factors: On the basis of these determinations, the final report will present recommendations for the improvement and maintenance of the lagoon and the precautions that should be taken against any chemical or physical damages due to man's activities within the lagoon. As we have stated previously, there is adequate space within the lagoon for wildlife, recreation and some limited haber development. We are inclined toward the view that with proper planning

INVERTEBRATES BY HABITAT AND ROLE, RELATIVE IMPORTANCE, RELATION TO BOTTOM

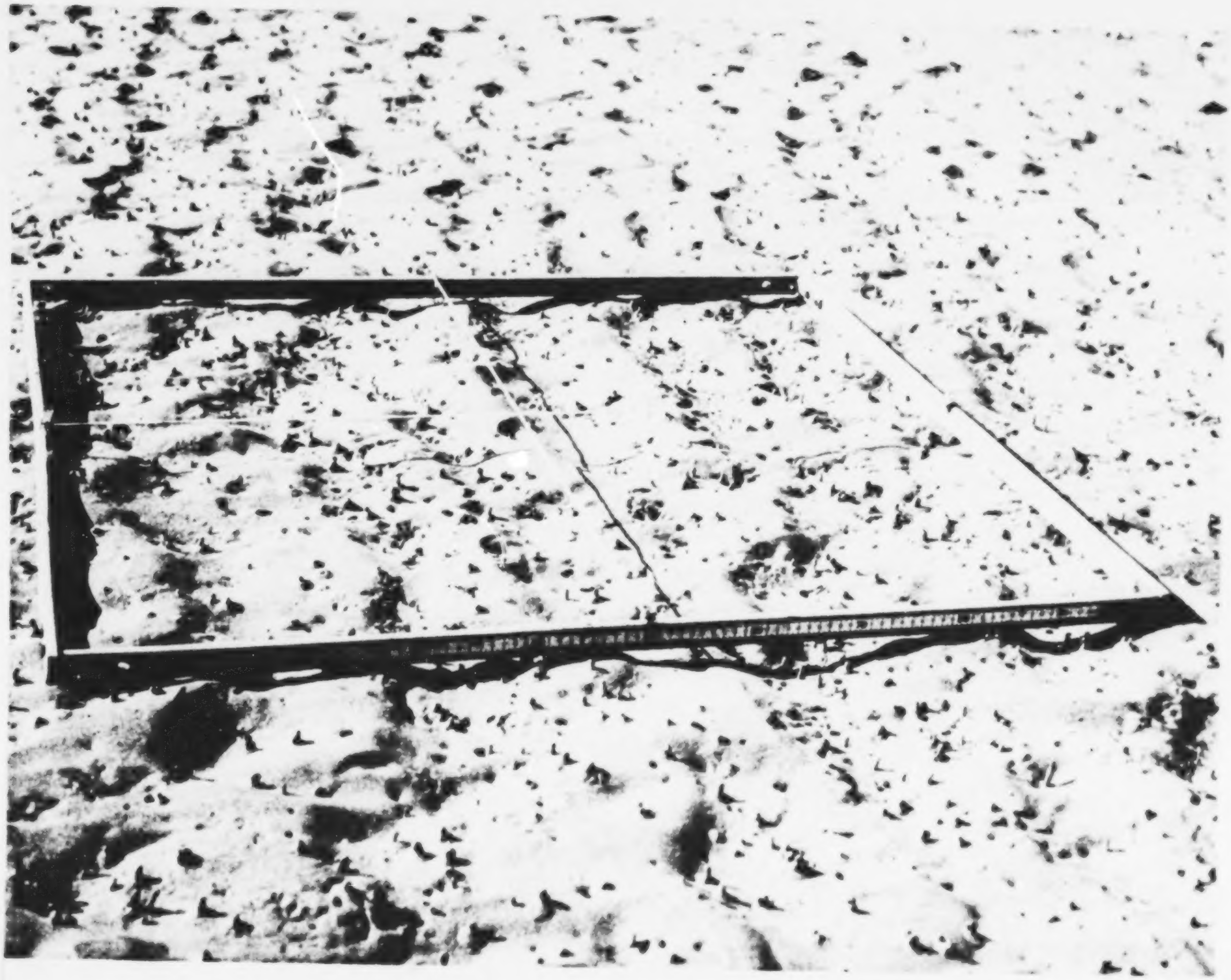
| Species | Role | # of stations (of 31) | Sand | Sand-mud | Mud | Widely Distributed | Importance** |
|---|---|---|---|---|---|---|---|
| several species, ribbon worms | predators | 17 | + | + | 0 | + | not abundant |
| leph worms<br>Phoronopsis viridis | filter feeders | 3 | + | ++ | 0 | 0 | questionable |
| joint worms<br>Axiothella rubrocincta | " " | 6 | + | ++ | 0 | 0 | " |
| boccardia worms, 3 species<br>Boccardia spp. | tentacle feeders | 9, 3, 3 | 0 | + | ++ | 0 | " |
| mud worms, species 1<br>Capitella capitata | mud feeders | 11 | 0 | + | ++ | 0 | " |
| mud worms, species 2<br>Lumbrineris zonata | " " | 13 | + | +++ | 0 | + | very |
| mud worms, species 3<br>Maldanids spp. | " " | 10 | + | ++ | 0 | + | some |
| mud worms, species 4<br>Mediomastus californiensis | " " | 11 | + | ++ | 0 | 0 | some |
| mud worms, species 5<br>Notomastus tenuis | " " | 14 | + | +++ | + | + | very |
| amphipod species 1 of 3<br>Ampelisca sp. | algal feeder | 10 | 0 | + | ++ | + | questionable |
| amphipod species 3 of 3<br>Corophium spinicorne | " " | 24 | + | +++ | +++ | + | very |
| red ghost shrimp*<br>Callianassa californiensis | sand-detritus feeder | 2* | + | ++ | 0 | 0 | moderate |
| blue ghost shrimp*<br>Upogebia pugettensis | filter-detritus feeder | 4* | 0 | +++ | + | + | some |
| purple shore crab<br>Hemigrapsus oregonensis | scavenger | 9 | + | ++ | ++ | + | some |
| sand clam<br>Cryptomya california | filter feeder | 8 | + | ++ | + | + | slight |
| bent nosed clam<br>Macoma nasuta | " " | 7 | + | ++ | 0 | + | some |
| gaper clam*<br>Tresus nuttallii | " " | 0 | + | ++ | 0 | 0 | some |
| Washington clam*<br>Saxidomus nuttalli | " " | 0 | + | ++ | 0 | 0 | some |

* not usually obtained in our shallow 15 cm sampling core.

** frequence of occurrence in fish and bird stomachs, and importance in fish and game and zoning, a harbor development could produce an enhancement of the wildlife production and potential within the lagoon. This optimistic thought presupposes that any development will employ and conform to the best planning and zoning concepts, both of which rely upon the ecological evidence in reaching their conclusions.

### RELATIONS OF LAGOON GEOGRAPHY AND CHARACTERISTICS

| | near mouth | central lagoon | SE & NE ends |
|---|---|---|---|
| turbidity | low | high | very high |
| algal production | low | high | very high |
| bottom conditions | sandy | muddy, sand | sandy mud |
| invertebrate life | low | very high | low |
| juvenile fish | low | very high | some |
| shorebirds | low | very high | some |
| wading birds | low | very high | high |
| rating as to importance to wildlife in terms of food production | low | very high | high |
| necessity for habitat improvement | none | some | great |
| necessity for improvement of water circulation | none | some | great |



This sand flat has been lowered by tidal scour and so exposed hundreds of the sand tubes of the "joint worm", *Axiothella rubrocincta*.

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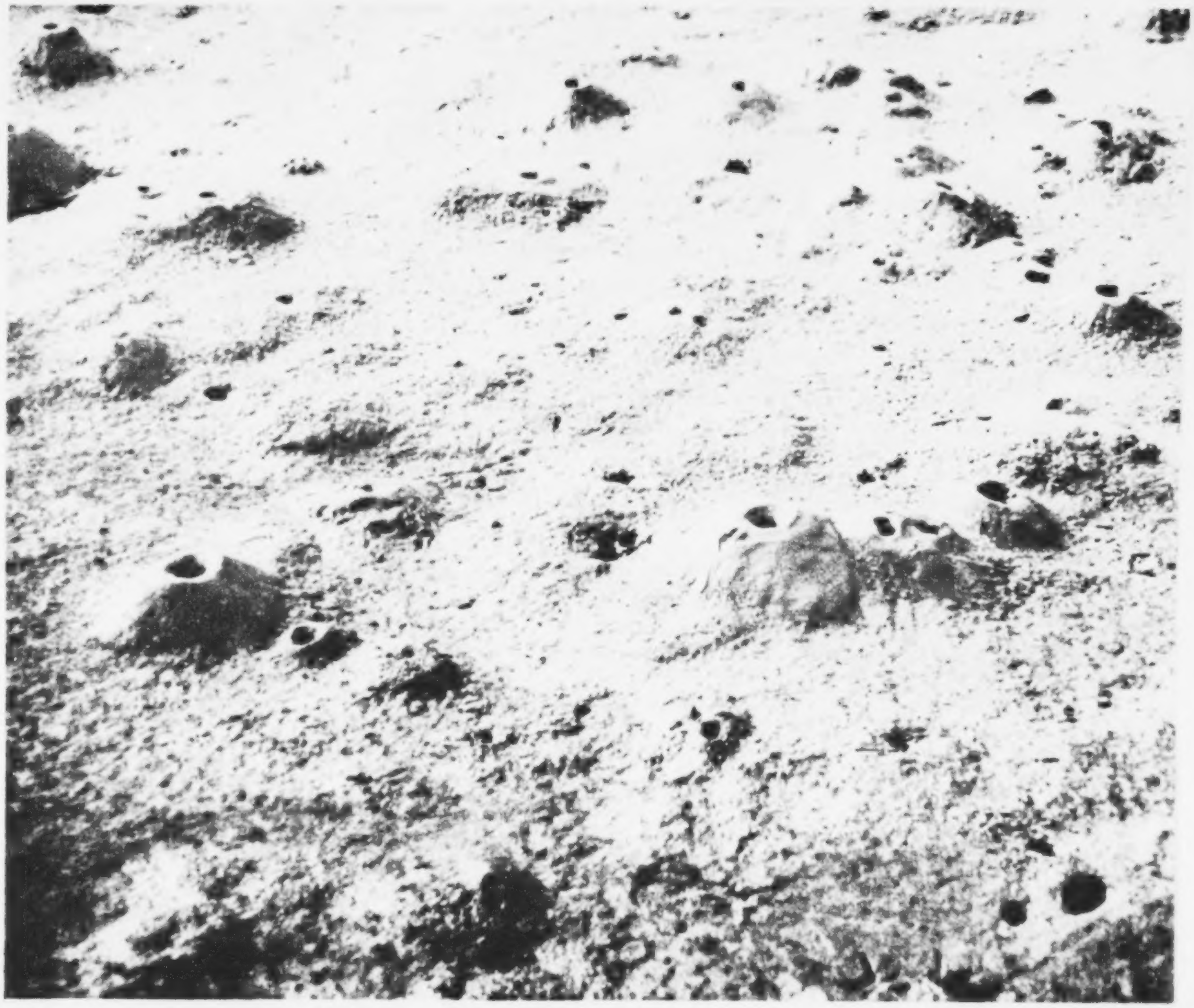

The burrow of the blue ghost shrimp, *Upogebia pugettensis*, is about 10-18" down in the muddy sand. The 2-3" cones mark the ends of the "U" shaped burrow. The other holes are made by the mud crab, *Hemigrapsus oregonensis*.

SAN FRANCISCO STATE COLLEGE
1600 HOLLOWAY AVENUE • SAN FRANCISCO, CALIFORNIA 94132

February 18, 1969

Gentlemen:

I would like to testify concerning some of the values of San Francisco Bay, including its mudflats, marshes and the streams that flow through these marshes. It has been widely reported that the Bay has dwindled in area by 33% during the last 100 years, but it is not so well known that the marshland surrounding the Bay has decreased in area by 75% during the same period. Accordingly I would like to focus on the importance of our marshes and the streams that flow through them into the Bay.

The San Francisco Bay environment has a great educational value. For many years we took classes in ornithology and vertebrate natural history to the marshes and mudflats at Alameda's Bay Farm Island to observe the myriads of shorebirds that used to occur there. Since the recent "development" of that property we have had to discontinue trips to that area and we now visit the somewhat less-productive area of Richardson's Bay. We have approximately 75 students each year in these classes; most of them become teachers and many of these become enthusiastic students of natural history and proponents of conservation as a result of these trips.

We have found that saltmarsh streams, which are miniature estuaries, also have a great educational value. I have studied one of these streams, Corte Madera Creek, for several years and have been impressed by the vast quantity of plant, invertebrate and vertebrate life that is produced there. I was also surprised to find that 20 or more species of marine fishes utilize this stream for several miles above its mouth. Such streams can truly be called "nursery grounds" for marine fishes, since juveniles of such important species as striped bass, rainbow trout, starry flounders and topsmelt occur there. We have taken many classes in ichthyology and animal ecology to this dynamic, productive estuarine environment.

I would finally like to plea for the conservation of the San Francisco Bay environment in general, and its marshes and streams in particular.

James P. Mackey
Associate Professor of Biology
San Francisco State College

James P. Mackey

Sierra Club
San Francisco Bay Chapter

Bay-Delta Water Quality Subcommittee
Preliminary Report
June 1968

## INTRODUCTION

The Sierra Club is concerned with maintaining the natural environment not only in select wilderness areas, where the works of man have had minimum impact, but also in areas where an enjoyable natural environment has persisted or reestablished itself next to man-made improvements.

An area of acute concern at present is San Francisco Bay, its upstream bays, and the Sacramento-San Joaquin Delta. This magnificent estuarine system is a priceless environmental resource, supporting a host of value-building activities from recreation to industry. Perhaps most important to millions is the appreciation of clean water in its channels and bays.

The wholesale diversion of Delta water by projects now operating, under construction, or being planned, together with increasing additions of agricultural, municipal and industrial wastes may reduce water quality in the system to the point that it becomes nothing more than a stagnating and foul-smelling open sewage drain.

The Club should act now to protect the quality of this region as a unique environmental asset.

## DISCUSSION

This section describes the Bay-Delta region, gives its history in terms of river flows, and lists the extent of diversions planned for the near future. Also discussed are the probable results of this flow attrition and the various factors contributing to the concomittant attrition of water quality. Finally, it describes the functions of a canal intended to by-pass the Delta in order to assure water quality at the export pumps.

### THE AREA

The environmental quality of the Delta, Suisun Bay and northern San Francisco Bay is largely governed by the inflow of clean water from the streams and rivers of the Central Valley watershed which is drained by the Sacramento River from the north and by the San Joaquin River from the south. Each river forms the side of a large triangle, the Delta, and the two rivers meet at the western point of the triangle near Antioch. The other corners are roughly the cities of Sacramento to the north and Stockton to the south, both of which have facilities to handle ocean-going ships. Tides entering the Golden Gate affect water levels in both rivers beyond the Delta, but for most of the time its channels contain fresh water which is used by local irrigators, municipalities, and industry.

The Delta contains some 50,000 acres of waterways with more than a thousand miles of shoreline. The downstream bays, including, of course, San Francisco Bay, have a surface area of 435 square miles with 276 miles of shoreline. Millions use these waterways for recreation, making the Bay and Delta both major recreational assets to northern California.

## HISTORY

Western man, in displacing the usufruct Indian, has changed many aspects of the region's environment by changing the pattern of water flows. The Delta was once a huge bog, interlaced with streams, covered with willows and tules, capable of absorbing the impact of major floods. Extensive diking has reclaimed a half million acres for river-irrigated agriculture, at the same time, however, constricting the flood plain's capacity. Hydraulic mining for upstream gold between 1860 and 1914 loaded the channels and bays with over 800 million cubic yards of gravels and sands, still further diminishing their ballast capacity to resist flood and tidal sea water inflow. Construction of the major upstream dams: Shasta, Friant, Folsom, and Oroville, has helped to control floods and to resist sea water inflow into the Delta area. Storage in them, though, is used primarily to provide summertime flows for irrigation, at the same time generating electricity as an important by-product. The sale of water and power pays back the construction costs of the dams and their delivery systems, at the same time serving to promote rapid economic development and population increases within the state.

Historically, recorded fresh water flows into the Delta have ranged between a maximum of 45 million acre feet during water year 1938 and a minimum of 7.6 million acre feet during water year 1924. (A water year begins on the first of October of the previous year and ends on the thirtieth of September). Peak flood flows of 445,000 cfs (cubic feet per second) on the 25th of December, 1964, and of 8.67 million acre feet during March 1907 have been measured, with the lowest continuous flow being around 2,100 cfs during August 1931, and a minimum flow of 1,100 cfs for around the 17th of July 1924. Extended low flows, as well as minimum flows, allow tidal action to pump saline water farther and farther upstream until, as in 1924 and 1931, saline water reached Stockton in the south and Courtland to the north. During these times the rivers were not much fit for irrigation or, for that matter, for navigation. Roughly 75 per cent of Delta inflow, that is, Central Valley outflow, comes from the Sacramento River and its tributaries, over 20 per cent from the San Joaquin, with the remainder from streams tributary to the Delta alone.

Sale and delivery schedules of water from upstream storage reservoirs are based on computations of the available supply, which in turn is usually predicated on data of five or more consecutive dry years within a series of at least 35 years. Low water years for Central Basin runoff were the seven "critical years" from 1927 to 1934. Shasta, Friant and Oroville as well as other dams will presumably run dry should a similar cycle recur. And as with historically recorded maximum and minimum flows, there is no assurance whatever that in the future conditions may not be worse than the seven critical years.

## DIVERSIONS

Increased upstream diversions and downstream demands showed after the construction of Shasta Dam (1944) that soon new supplies would have to be imported from other watersheds. Portions of plans to transfer additional water from north coast rivers have been implemented already with the construction of Trinity Dam, delivering water through Clear Creek Tunnel into the Sacramento River above Redding. Many other reservoirs, pumping plants and tunnels are designed for tapping north coast watersheds for export to the Central Valley Basin. Unless alternatives are developed, increasing use will have to be made of these rivers to fill a growing basin deficit.

Where Delta inflows have averaged somewhere between 20 and 30 million acre feet a year, present upstream diversions reduce this to around 17 million acre feet, and projects now under construction may cut this to as low as a little over one million acre feet at the end of a series of dry years, or to around 2.5 million acre feet in a median year. Diversions take place all along the streams and rivers leading to the Delta, but the major diversions are or will take place in the Delta near Tracy. Export pumps of the Bureau of Reclamation can divert 3.33 million acre feet per year, serving the Delta-Mendota Canal; the state's pumps will export 4.43 million acre feet a year by way of various aqueducts, project water going as far south as San Diego. Both delivery systems have their own canals and pumping plants, but both depend at present on the inflow of a single channel, the Sacramento River and on the Delta waterway-reservoir.

## FLOW ATTRICTION AND SALT INTRUSION

It is easy to see that increasing upstream diversions will reduce the volume of water reaching the Delta and needed at the export pumps to fill increasing contract requirements. Water pumped out at Tracy is presently drawn from the many channels of the Delta waterways which act as a fresh water reservoir, with one corner, however, open to the bays and to ocean water coming through the Golden Gate. Heavy summertime pumping when river inflows are low will cause salt water to be drawn into the Delta at Antioch. Salt incursions are detrimental not only to the municipal, industrial and agricultural users, but to the adjacent marshlands as well. Salt water unfit for irrigation might even reach the pumps during certain dry years.

Proposals for blocking sea water inflow include the establishing of criteria for minimum flows past Antioch. Physical barriers have been rejected because of potential damage to the fishery resource in that migrating fish raised at hatcheries below the major dams must pass to and from the ocean through a gradual transitions zone of brackish water. Minimum outflows of above a certain number of cfs will safeguard Delta users and the established ecology.

Naturally there is disagreement as to the exact minimum outflow required to block salt intrusion, especially with the fight for available water developing. Corps of Engineers estimates range from a high of 7,500 cfs to a 1949 minimum of at least 4,600 cfs. The State's Department of Water Resources has, however, revised its minimum criteria from its 1924-1928 water supervisor's report of 4,000 cfs down to 3,300 cfs, to its present 1,500 cfs. It seems reasonable that the enlarged Bay-Delta model of the Corps of Engineers in Sausalito, coupled with a computer model, will furnish an easily agreed-upon minimum, providing agreement is reached on the maximum salt intrusion to be permitted. But beyond this minimum, another will have to be agreed on in order to safeguard the necessary seasonal purging of the downstream bays, at least until present pollution and contamination levels are drastically reduced. The bay is essentially flushed in one month, and flushing of the system is practically complete in two months with a Delta outflow of 25,000 cfs. This flushing of the accumulated pollutants has been accomplished almost every winter which has included any one of the following Delta outflows: 2 million acre feet in any one month, 3 million acre feet within two consecutive months, or a total of 4 million acre feet in any four consecutive months.

## QUALITY ATTRITION

A reduction of water quantity usually means a parallel reduction in its quality. Falling rain or snow contains atmospheric dust and gases in solution. Once on the ground it slowly begins to dissolve the rocks and sands past which it flows, gradually building up its mineral load. Evaporation along the way, from lakes and reservoirs especially, further concentrates these minerals. Once in soil, water picks up minerals that are more rapidly being dissolved by the acids and enzymes of the myriad bacteria that are able to directly attack stone. Plants growing in soil (or mineral-containing water) use only what they need or can use at that time. The remaining minerals are further concentrated to the point where they become poisonous. The gradual build-up of salts in the root zone has made areas of the Central Valley less and less productive. Additional water must be used to flush these chemicals down or out. This "used" irrigation water then flows either into the San Joaquin River or the ground water supply. Unless sufficient extra fresh water is added neither can be used for irrigation. A further hazard is the fact that this return flow contains traces of the exotic chemicals used to kill plant pests, to promote plant vigor, and to perform a host of other functions such as defoliating cotton, causing fruit to drop, etc.

Irrigation waste flows are toxic to life and must be removed from the area to prevent contamination. It was agreed to by most that subsurface drains, tile pipelines 6 to 8 feet deep, are needed to collect the wastes away from the 7 foot region in which most plants have their roots. It is also agreed that a master drain is needed for the entire San Joaquin Valley to keep the effluent from further contaminating the ground supply. Both Federal and State plans call for separate drains although a joint system has been proposed. The common terminal for both is at Antioch.

Agricultural drains carry excess fertilizer, primarily in the form of nitrate-nitrogen plus sulfate and traces of phosphate. Nitrate and phosphate, in conjunction with other ingredients found in Bay waters, will promote rapid algal growth in the presence of light. Quantities of nitrate in the drain are given as around 20 ppm, and are far more than are needed to promote algal "blooms", a sudden population explosion beyond the sustaining capacity of the system. The water becomes turbid, cutting off light, stopping photosynthesis, and causing algae to die. Their decay in turn demands oxygen from the limited amount dissolved in the water. The resulting shortage of oxygen contributes to the death not only of more algae, but also to the asphyxiation of most other forms of aquatic-life. This includes clams, snails, and especially fish. The process is called eutrophication and it takes a fairly static lake or bay considerable time to recover. Meanwhile it is a foul mass, commonly referred to as "black water". Even if the nitrate-nitrogen and other nutrients were removed from agricultural waste waters, boron and exotic chemicals still left would contribute to an underwater "smog", generally affecting first the most highly prized species, namely fish. Traces of insecticides as low as fractional parts per billion are stored by various metabolic processes in fish to where they are unfit for human consumption when they are finally caught. Each year more and more of these exotic chemicals are introduced into agriculture with little or no knowledge of the effects they might have on the aquatic food chain involved.

Water used by homes and industries also becomes degraded by being loaded with wastes before being discharged by treatment plants. More than 60 sewage plants discharge as much as 400 million gallons per day (mgd) into the Bay-Delta system. Human and certain industrial wastes contain nutrients in such abundance that they need to be further oxidized to become harmless. When these wastes enter a body of water they also require oxygen to decompose, as in the case of dying algal blooms. This biochemical oxygen demand (BOD) is furnished by the dissolved oxygen (DO) in the water. The amount of oxygen and water available for the disposal of wastes is called the assimilative capacity of the receiving water and is considered a beneficial use of that river or bay. The assimilative capacity of the Bay-Delta estuarine system is not limitless. Allowing a minimum of 5 ppm of dissolved oxygen for the sustenance of aquatic biota, not much more than another 5 ppm is available for the reduction of waste.

Combine the BOD of nutrient-induced algal blooms from agricultural drains with rapidly rising volumes of human and industrial wastes, add to this the many new exotic chemicals, and couple it all with drastic reductions in minimum and purging flows and you have the specter of a total kill of the region's aquatic life.

## THE PERIPHERAL CANAL

Prior to the state's project at Oroville and its aqueduct from Tracy to Los Angeles, the Federal pumps serving the Delta-Mendota canal caused several problems. One is the pumping out of some 35 million floating striped bass eggs yearly, another the trapping of up to 40 thousand small fry a day which are powerless against the 3-1/2 mph intake current. These are diverted by louver screens into tanks for delivery to safer areas farther away. Bottom feeding fish are also adversely affected by fast flows. Another problem has been the reversal of normal flows within the Delta, with water flowing to the pumps rather than to sea. This tends to confuse fish that migrate, such as salmon, causing many to become lost and to fail to spawn. Another detrimental factor to the fishery has been a pollution block near Stockton. Finally, San Joaquin River return flows containing agricultural wastes have caused some deterioration of water quality at the pumps.

The state's demands at their pumps will aggravate these conditions, presumably depressing the water level of many channels enough to pull sea water in through the open corner at Antioch and causing further reductions in quality. The pumps, however, will serve both agriculture and the metropolitan centers in southern California, the latter having set more stringent quality as well as quantity standards on what they are to receive. Delta water will no longer meet the standards if it is permitted to mix with sea water inflows and San Joaquin River return flows.

It is imperative now that the Delta be by-passed in order to preserve water quality at the export pumps and that a joint Federal-State project, a common channel, be built to tap the Sacramento River near Hood. Canal design provides for release facilities at various points in the hope that the composite flow toward Antioch will keep sea water out, flush pollutants from the Delta, and maintain the quality of the fish habitat. Apparently certain kinds of game fish will spawn only in waters containing less than 180 ppm (parts per million) of dissolved salts. Releases from the canal will be needed to assure good spawning areas. Releases near Stockton could also do much to help remove a pollution block near Stockton which has practically stopped San Joaquin River fish migrations. The matter of how much water to release when and where from the peripheral canal is still open to discussion. Plans at present allow releases totaling roughly 1.5 million acre feet a year for studies alone with no assurance that this is the minimum amount. Also under discussion is the minimum flow required for fish migrations in the Sacramento River below the intake facilities. The U. S. Fish and Wildlife Service would like not less than 1,500 cfs but there is no guarantee that this amount will be available in certain dry years.

## CONCLUSIONS

The following conclusions are based on the discussion and on a review of the generally available literature listed under "References":

1. Planned reductions in Delta outflow to a 1,500 cfs minimum will promote salt water intrusion into Delta waterways and thus shift the salt-to-fresh water gradient as much as 20 miles upstream. This will change the ecology within the transition zone and may kill the marshes presently supporting bird migrations along the Pacific Flyway.

2. Delta inflow reductions will adversely affect water quality within the Bay-Delta system. Low flows will contribute to the stagnation of the Delta's internal waterways, reduce the rate of removal of municipal, industrial, and agricultural wastes, and adversely affect fish reproduction and migrations.

3. Upstream storage and diversion projects will probably reduce seasonal 'purging' flows to insignificance. These flows appear necessary to effectively remove accumulating pollutants from the Bay-Delta system.

4. Continued increasing discharge of human and industrial waste into the system may overload its assimilative capacity, especially with reduced advective flows. Overloading asphyxiates fish and other marine forms by reducing the available supply of oxygen.

5. The planned introduction of agricultural drainage wastes into the Bay-Delta system may have severely adverse effects on the region's aquatic ecology. The effect of nutrients will be to further tax the assimilative capacity; exotic chemicals may cause underwater 'smog' contribute to fish kills, and have long-term side effects.

6. Construction of a canal from the pumps to bypass the Delta is probably necessary to mitigate the effects of increased pumping on the Delta fishery and Delta water quality.

7. Peripheral Canal intake facilities, operating near design capacity, may prove to be a severe handicap to migrating fish. Proper releases from the canal, however, may improve water quality and the fish habitat in the southern Delta.

8. The proposed widening and deepening of the navigational channels to Stockton and Sacramento may have possible

adverse effects on water quality by allowing salt water to intrude below reduced fresh water outflows.

9. Thermal pollution, although not discussed, may reduce oxygen content, alter marine biota, and interfere with migrating fish.

RECOMMENDATIONS

1. Minimum guaranteed Delta fresh water outflows should be at least 4,600 cfs and never less than 3,300 cfs at any time. This minimum will hopefully preserve San Francisco Bay water quality by aiding the steady removal of wastes; it should help to save Suisun Marsh, a great wildfowl resource; it may protect the anadromous fishery and maintain the Delta as a prime recreational asset for millions in northern California.

2. Seasonal 'purging' flows should be at least 2 million acre feet in any one month, 3 million acre feet in any two consecutive months, or 4 million acre feet in any four consecutive months, until Bay-Delta pollution and contamination loadings are drastically reduced.

3. All disposals of municipal, industrial, and any other wastes into the Bay-Delta system should be brought up to "secondary plus chlorination" levels as soon as possible. Plans for tertiary treatment should be initiated now.

4. The Bay-Delta system should be considered a prime regional recreational asset and should be included in federal and state projects and plans as such. The

attaching of "pocket" parks to future development in no way compensates for the possible loss of environmental quality within the entire area.

5. Under no circumstance should the proposed agricultural drains enter the Bay-Delta system, denitrified or not. Off-shore ocean trench dispersal is to be recommended as the less offensive alternative. Impetus should be given to legislation requiring the use only of short half-life or biodegradable exotic chemicals.

6. The Peripheral Canal should be built as soon as practicable, providing firm assurance is given that proper releases to Delta channels will serve to guarantee item 1 above, protect Delta water quality, and maintain the Delta fish habitat.

7. Fish screening and diverting devices of the latest design should be provided at the Hood intake, and adequate flows should be assured in the Sacramento River below Hood. A minimum of 1,500 cfs is under consideration by the State Department of Fish and Game.

8. Corps of Engineers projects for widening and deepening navigational channels should be tested in model form first to insure that they will not hasten the tidal inflow of salt water.

9. Thermal pollution effects on estuarine ecology should be thoroughly investigated before massive heat insertions are permitted.

Further .......

10. All water storage, flood control, and hydroelectric projects within the state, whether federal, state, or utility managed, should be integrated for computer logic control in order to best manage our water resource.

11. The basic Bay-Delta system outflow minimum (item 1 above) should be written into policy and law. Upstream storage capacity should be allotted to meet this requirement, and sufficient releases should be made solely for the purpose of maintaining regional water quality.

12. Further diversions, planned but not approved, should not take place from the Sacramento-San Joaquin watershed.

13. We should not encourage the short-sighted exploitation of the state's north coast watersheds; we should rather insist on accelerated plans and projects for desalting sea water.

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STATE OF CALIFORNIA—RESOURCES AGENCY
RONALD REAGAN, Governor

**DEPARTMENT OF WATER RESOURCES**
CENTRAL DISTRICT
3251 S STREET
P.O. BOX 9137
SACRAMENTO 95816

MAR 1 0 1969

Mr. James McCarty
Pacific Southwest Region
Federal Water Pollution Control Administration
760 Market Street
San Francisco, California 94102

Dear Mr. McCarty:

Our representative, who attended the public meeting of February 18 and 19 on Water Quality Management for Estuarine Areas, advises me that the June 1968 preliminary report of the Sierra Club's Bay-Delta Water Quality Subcommittee, was made a part of the official transcript of the proceedings.

At the request of Mr. Eugene A. Brodsky, Conservation Chairman, Sierra Club, the Department reviewed and furnished comments to the San Francisco Bay Chapter on this preliminary report. By this letter I am furnishing you with a copy of our comments and request that they be made part of the official transcript which, I understand, remains open until March 14, 1969.

Sincerely yours,

Carl A. Werner
District Engineer

Enclosure
cc: Mr. W. A. Alexander, Vice Chairman
State Water Resources Control Board
Rm. 1140, 1416 Ninth Street
Sacramento, California 95814

DEC 10 1968

Mr. Eugene A. Brodsky
Conservation Chairman
Sierra Club
San Francisco Bay Chapter
667 - 47th Avenue
San Francisco, California 94121

Dear Mr. Brodsky:

Thank you for the opportunity to review and comment on your preliminary report of June 1968 on Bay-Delta Water Quality. The list of references cited certainly shows extensive effort on your part to become informed on this matter.

The Department shares your objective of protecting the environment of the Bay and Delta for use as a prime recreation and fish and wildlife resource, as a necessary part of developing the water resources to meet the growing needs of the people of the State. We are pursuing programs which we believe will achieve the best use of Delta water for the greatest number of people and will provide for the long-range welfare of the State as a whole, including the Delta area. With this in mind, we offer the following comments for your consideration.

Your report is directed toward possible damage to the Delta and the Bay. Major emphasis is on the possible adverse effects of upstream water resources development and export, with only secondary attention given to water pollution. In addition, there are three major factors not considered which, if considered, I believe would lead to substantially different conclusions.

First, we believe that recognition should be given to measures being undertaken at all levels of government to maintain and improve the region's environment. Constitutional and legislative mandates that guide these programs must also be considered: For example:

(1) Article 14, Section 3, of the California Constitution, requires that waters of the State be used in a reasonable and beneficial manner, without waste;

(2) Section 12202 of the Water Code provides for salinity control and substitute water supplies in the Delta;

(3) The conclusions and recommendations of the California Water Plan should also be recognized, since this plan was adopted by the Legislature in 1959 to serve as a framework to guide the overall development of the State's water resources; and

(4) The report should also consider that the San Francisco Bay Area obtains much of its present water supply from the Central Valley and that much of the water to satisfy the future needs of the Bay Area probably will come from either the same source or the North Coast.

We also believe that your report should recognize the distinction between two particular points -- (1) pollution and its remedies, and (2) salinity intrusion and means for its control. Salinity intrusion is a natural phenomenon associated with tides and riverflows. It must be clearly distinguished from pollution, which results from sewage and waste discharges.

Plans for development and utilization of water in the central valleys call for releases of stored water for controlling salinity intrusion in the Delta, as well as for transporting water across the Delta. Facilities for the Delta include the Peripheral Canal, the Kellogg Project, and overland transportation facilities to serve the western Delta islands. The Peripheral Canal will redistribute Sacramento River water of good mineral quality throughout the interior Delta channels to freshen quality and improve conditions for the Delta fishery. Releases for salinity control and redistribution of water will provide a sound base condition for mineral quality of Delta water on which effective pollution controls can be administered. All of these measures are necessary to assure an adequate water supply for the Delta, Contra Costa County, and the State as a whole.

Wise use of our water resources requires that outflows of upstream water flowing through the Delta to control ocean salinity intrusion must be reasonable and not wasteful. Your report correctly points out that severe salinity conditions existed in the Delta in 1924 and 1931. In fact, before Shasta Reservoir began operation in 1944, severe salinity intruded into the interior Delta in 14 out of 24 years.

Since that time, however, the effects of seawater intrusion have been contained to the west of Rio Vista by releases of stored water. Rather than increase the freshwater flow through

DEC 10 1968

the Delta and into the ocean to the point of wastefulness, we propose overland transportation of high-quality water to areas in the western Delta where that method is more efficient than delivery through natural channels. This follows the legislative guidelines set forth in Section 12202 of the Water Code.

In the final analysis, criteria for salinity control must be established in conjunction with water rights permits for the State Water Project and the Central Valley Project, since the extent of salinity intrusion into the Delta is controlled by release of stored water from these projects.

Moreover, the Department does not plan to reduce the minimum Delta outflow to any specified amount, such as 1,500 second-feet. Both our Department and the U. S. Bureau of Reclamation advocate operation of their respective projects so as to meet the water quality criteria set out in the November 19, 1965 Delta Water Quality Criteria, regardless of the amount of water required for that purpose. A copy of this criteria is enclosed for your information. This approach avoids the need to specify the minimum outflow, which cannot be accurately measured. Rather than shifting the salinity gradient 20 miles upstream, as indicated in your report, the intrusion will not be allowed to advance upstream any farther than it has since the beginning of operation of Shasta Reservoir. This is over 20 miles downstream from the historic intrusion that occurred in 1931.

The November 19, 1965 criteria have been agreed to by representatives of the U. S. Bureau of Reclamation, the California Department of Water Resources, the Sacramento River-Delta Water Association, and the San Joaquin Water Rights Committee, as appropriate to provide an adequate water supply in the interior Delta. Under these criteria, the 10-day average, 1,000 parts per million chloride line will not be allowed to intrude upstream any farther than Emmaton (on Sherman Island) in the Sacramento River, and Jersey Point (on Jersey Island) in the San Joaquin River. This constitutes a vast improvement over natural historic salinity conditions in the Delta. The criteria also provide for springtime flushing to the extent that mean daily chlorides will not exceed 200 ppm for at least 10 consecutive days during April or May at the Emmaton-Jersey Point stations. In addition, it provides for maintaining Class 1 irrigation water throughout the interior Delta measured at 5 key interior stations.

To the extent that additional freshwater supplies are needed to serve the western Delta, these will be furnished through overland conduits to the extreme western Delta islands (Hotchkiss, Jersey, and Sherman), and through the proposed Kellogg Project and Contra Costa Canal to serve northeastern Contra Costa County. Furthermore, the Department of Fish and Game has indicated, in Report No. 7, Summary Progress Report, Delta Fish and Wildlife Protection Study, that the November 19 criteria provide the framework in which most, and perhaps all, environmental needs of fish and other aquatic life can be attained with proper operation of the Peripheral Canal. A copy is enclosed for your information.

Insofar as the San Joaquin Drain is concerned, we recognize that no one has a "right to pollute waters of the State". Treatment of the drain waters will be undertaken to the degree that is necessary to protect the Delta.

Responsibility for controlling water pollution rests with the Regional Water Quality Control Boards and the State Water Resources Control Board. This applies to the San Joaquin Drain as well. As you are aware, the State Board is conducting the San Francisco Bay-Delta Water Quality Control Program authorized by the Legislature in 1965 to determine what can best be done to correct and prevent pollution of waters of the Bay-Delta area, caused by agricultural drainage and municipal and industrial wastewater discharges. Its final report to the Legislature is due early next year. To best serve the public interest, I believe it would be well to consider rescheduling completion of your report for two or three months so that you could have the benefits of this important study.

Attached are detailed comments on the report prepared by the Department staff. If you would like additional information, please feel free to contact me at your convenience. If you would like members of our staff to discuss the issues with your group, please contact Mr. Carl A. Werner, District Engineer, Central District, Department of Water Resources, P. O. Box 9137, Sacramento, California 95816.

Thank you again for the opportunity to review and comment on your report.

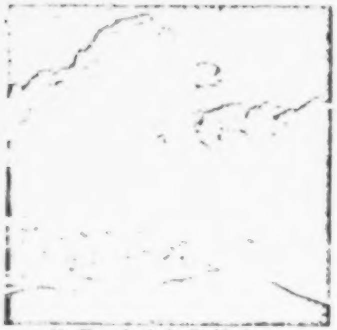
Sincerely yours,

(sgd) W. R. Gianelli

Director

Enclosures
cc: Mr. Claude A. Look, Chairman
Northern California Conservation Committee
411 Los Ninos Way
Los Altos, California 94022

Dr. Edgar Wayburn, President
Sierra Club
1050 Mills Tower Building
220 Bush Street
San Francisco, California 94104



Mt. Tamalpais by Pirkle Jones

SIERRA CLUB
*San Francisco Bay Chapter*

October 14th, 1968

Mr. William R. Gianelli, Director
Department of Water Resources
Post Office Box 388
Sacramento, California

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46
[illegible]

Dear Mr. Gianelli:

D. Thompson

Your letter of September 23rd, 1968, addressed to Edgar Wayburn, M. D., has been referred to the San Francisco Bay Chapter for reply.

We are very glad to learn that the Department of Water Resources shares our concern over preservation of water quality in the Sacramento-San Joaquin Delta. It was this concern which lead the Chapter to commence a study of the Bay-Delta and issue the Bay-Delta Water Quality Preliminary Report. As the letter of transmittal indicates, however, the Report is preliminary and sets forth the views of the San Francisco Bay Chapter, and not those of the Club. Although the Preliminary Report was presented to the Northern California Regional Conservation Committee, no action has been taken to date by that Committee.

We understand that your staff will have a further opportunity to meet with representatives of the Northern California Regional Conservation Committee prior to the adoption of the final recommendations. Members of our Bay-Delta Water Quality Subcommittee will take part in such a conference.

We hope that your Department will accept our invitation to submit written comments concerning the findings and recommendations of the Bay-Delta Water Quality Preliminary Report. We would appreciate receiving such comments before mid-November, and prior to any staff conference.

cc - [illegible]
D. Thompson
J. McClurg

1/6/68

File 1568

We trust that your Department and the Sierra Club can cooperate in the protection and enhancement of the Bay-Delta System.

Very truly yours,

SAN FRANCISCO BAY CHAPTER
SIERRA CLUB

By
Eugene A. Brodsky
Conservation Chairman

EAB:bam
cc: Edgar Wayburn, M. D.

J. McClurg ✓

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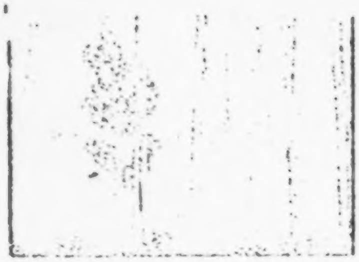

by Ansel Adams in This Is the American Earth

SIERRA CLUB Mills Tower, San Francisco 4

October 1,1968
411 Los Ninos Way
Los Altos, Calif.

Mr. William R. Gianelli, Director
Department of Water Resources
P.O. Box 388
Sacramento, Calif.

281.5
S-6

Dear Mr. Gianelli:

In regards to your letter of September 23,1968 in which you referred to the Sierra Club's Bay-Delta Water Quality Preliminary Report addressed to Dr. Edgar Wayburn.

I believe the report in question was issued by the Bay-Delta Water Quality Committee of the San Francisco Bay Chapter of the Sierra Club and not by the Northern California Regional Conservation Committee to which you refer.

The Northern California Regional Conservation Committee will fulfill its promise to meet with the representatives of the Department of Water Resources and other agencies at an early date to continue gathering the basic material needed to complete the report of the Northern California Regional Conservation Committee.

We regret, as did the members of your staff, that there was insufficient time at our meeting on June 22,1968 for a more detailed presentation by the members of the Department of Water Resources. They did have more than the 10-20 minutes to which you refer but none the less it was not sufficient time to cover such a complicated subject or subjects. It was a case of our committee trying to cover too much ground in too littl time and I assume full responsibilty for this.

We appreciate your offer for the use of the facilities in the Resources Building for a further discussion of the Bay-Delta problems. We will contact the members of our committee and then consult with your Department in regards to a suitable date.

Sincerely,

Claude A. Look

Claude A. Look, Chairman
Northern California Conservation Committee
Sierra Club

cc- Dr. Wayburn
Mr. McCloskey
Mr. Munger
Mr. Brovsky

rc J Teerink
C Ward
J McClurg

## DETAILED COMMENTS ON "BAY-DELTA WATER QUALITY PRELIMINARY REPORT"

Listed below are detailed comments by the staff of the Department of Water Resources on the "Bay-Delta Water Quality Preliminary Report", June 1968.

Page 2: Under the heading "Discussion", the last sentence is:

> "Finally, it describes the functions of a canal intended to bypass the Delta in order to assure water quality at the export pumps."

The phrase "and within the Delta" should be added at the end, since the Peripheral Canal not only bypasses the Delta, but makes releases at key locations to serve the Delta's uses, to help repel saline intrusion, and to improve conditions for fish and other aquatic life.

Page 4: This page of the report goes into considerable detail over historical flow conditions that have occurred in the Delta and resultant saline intrusion. We agree that severe salinity intrusion, during dry hydrologic years, was experienced in the Delta prior to the operation of the Central Valley Project. However, since 1944, summertime releases of stored water for salinity control from upstream reservoirs have prevented recurrence of such salt invasions. Under operation of the State Water Project, the maximum extent of saline intrusion will be approximately the same as has occurred under operation of the Central Valley Project.

Page 5: The last sentence of the first paragraph is:

> "And as with historically recorded maximum and minimum flows, there is no assurance whatever that in the future conditions may not be worse than the seven critical years."

We agree there is no such assurance that future hydrologic conditions may not be as severe. However, mineral quality conditions will never be as poor in the future as they were prior to the operation of the Central Valley Project. Ability to maintain suitable mineral quality water within the Delta is inherent in the coordinated operation of the State Water Project and the Federal Central Valley Project. Fulfillment of the November 19, 1965 Delta Water Quality Criteria, a condition of the water rights for the State Water Project and adopted as interim water quality standards for the State Water Resources Control Board, provides this guarantee.

Page 7: The first three sentences of the first paragraph are:

> "Heavy summertime pumping when river inflows are low will cause salt water to be drawn into the Delta at Antioch. Salt incursions are detrimental not only to the municipal, industrial, and agricultural users, but to the adjacent marshlands as well. Salt water unfit for irrigation might even reach the pumps during certain dry years."

We recognize this relationship and it is built into the joint operational criteria to provide adequate quality water. One must realize that severe salinity intrusion was experienced in the Delta prior to the operation of either the federal or state water projects. The Peripheral Canal will eliminate the possibility of saline water being drawn into the Delta by the pumps. The state and federal projects, of which the Peripheral Canal is a portion, will be operated within the limits of the November 19, 1965 Delta Water Quality Criteria. This, in turn, provides for a westerly flow past Chipps Island which will prevent such flow reversals. In addition, releases will be made at key locations along the Peripheral Canal to freshen the quality of Delta waters, to assure a westerly flow past Antioch, and to improve conditions for the Delta fishery.

Pages 7 and 8: These two pages infer numerical outflows as being the solution to the preservation of water quality within the Delta.

The waters flowing into the Delta must be managed for the protection of its legally vested rights and for the greatest public good. No solution is meaningful unless a proper balance between these needs is achieved. Quality limits, such as the November 19, 1965 Delta Water Quality Criteria, are an effective method of preserving the Delta's mineral water quality. Regardless of amount, the flow necessary to meet these criteria will be released from upstream reservoirs. This establishes an effective base condition for mineral quality and upon which effective measures for controlling pollution can be employed.

Page 10: This page discusses and makes some rather profound statements on the effects of agricultural drain water. In reality, much of the discussion presented is conjecture with respect to the drain. The inference that drain waters mixed with Bay waters will promote rapid algal growth is not based on fact. In reality, there is an excess of nitrogen present in the Bay waters now with no algal growth. Studies indicate that light penetration may be the controlling factor. The last sentence:

> "Each year more and more of these exotic chemicals are introduced into agriculture with little or no knowledge of the effects they might have on the aquatic food chain involved",

is incorrect. Facts show less and less chlorinated hydrocarbons are in use in San Joaquin Valley. For example: None, according to the records, were used in Stanislaus County in 1967.

Pages 11 and 12: The last paragraph on page 11, which carries over to page 12, is overdone. The specter of a total kill of the region's aquatic life is an impressive statement but not based on fact. Many studies are being, or have been, undertaken by many agencies to find ways to preserve the Delta and Bay. Two examples of such studies are the cooperative Delta Fish and Wildlife Protection Study undertaken jointly by the Department of Fish and Game and Department of Water Resources, and the Bay-Delta Water Quality Control Program being conducted by the State Water Resources Control Board. The latter is a special planning program established by the Legislature to determine the best means of correcting and preventing damages to the quality of the San Francisco Bay and Delta waters which may be caused by drainage and waste-water discharges, or by other activities that may lead to water contamination or pollution. This program's findings and recommendations are scheduled to be presented in a report to the Legislature in January 1969.

Page 12: The first paragraph on this page deals with the Delta fishery, while the last sentence deals with the return flows of the San Joaquin River causing some deterioration of water quality at the pumps.

We suggest that the following excerpt be added:

> "The Departments of Water Resources and Fish and Game, along with the U. S. Bureau of Reclamation, are actively taking steps to protect the Delta fishery. Releases from the Peripheral Canal not only will freshen the quality of waters within the Delta, but will improve conditions for the Delta fishery as well."

Pages 12 and 13: The last paragraph on page 12 which continues on page 13, cites reduction in Delta water quality due to pumping. It also mentions quality and quantity standards for Southern California.

All water resources planning in the State, not just the Delta, is predicated upon wise conservation and use of water. Maintenance of the November 19, 1965 Delta Water Quality Criteria will limit the extent of maximum salinity intrusion into the Delta to essentially the same levels as experienced today nd will provide far better mineral quality water in the Delta than existed in dry hydrologic years prior to the operation of the Federal Central Valley Project.

## Conclusions

No. 1: This conclusion states that planned reductions in Delta outflow will promote saltwater intrusion into Delta waterways and thus shift the salt-to-fresh water gradient as much as 20 miles upstream, change the ecology of the transition zone, and may kill the marshes presently supporting bird migrations along the Pacific Flyway.

No plan advocated by the Department of Water Resources, or any responsible agency, shifts the salinity gradient 20 miles upstream. The November 19, 1965 Delta Water Quality Criteria provides that salinity will not intrude into the Delta any farther than it does now. This is more than 20 miles downstream from historic salinity intrusion occurring in 1931. The Department advocates that this criteria be met by project operation regardless of the amount of outflow required.

No. 2: This conclusion states that Delta inflow reductions will adversely affect water quality within the Bay-Delta system, and cites possible effects of such a reduction.

The Peripheral Canal, when operational, will provide for transfer of water around the Delta to the state and federal pumping plants, isolated from the existing Delta channels. Works will be included to release water along its route to serve the functions of water quality control for local water supply, repulsion of sea water, and fish and wildlife protection and enhancement. The Peripheral Canal has additional advantages over other plans studied, in that it will not interfere with navigation, recreation, and boating use in the Delta, nor add to problems of seepage or flood control. Removal of exports directly from the southern Delta channels will stop present drawdown and possible scour problems. However, no one has the right to pollute and the waste discharges will have to be controlled to prevent adverse effects from pollution.

No. 3: We agree that "flushing" should be provided for the Delta. In fact, provisions for flushing the Delta to the extent that chlorides will not exceed 200 ppm at Jersey Point and Emmaton at the beginning of the irrigation season are made in the November 19, 1965 Delta Water Quality Criteria.

No. 4: We agree that increasing discharge of human and industrial wastes into the system may overload its assimilative capacity.

Waste assimilative capacity in the western Delta results from a complex relationship of many factors including aeration, tidal diffusion, photosynthesis, etc. Tidal action overshadows net outflow as a source of dissolved oxygen in the western Delta during the critical summer months. Only during large floods does the outflow contribute a substantial amount of dissolved oxygen to the waters of the western Delta. Consequently, the effect, if any, of project operations on the assimilative capacity will be negligible, since project facilities will not reduce the total outflow significantly during periods of large floods.

In regard to accumulating pollutants in the Bay and Delta, no one has the right to pollute. The need for, and feasibility of, a master waste collection and disposal system to serve the entire Bay-Delta area is the subject of the current Bay-Delta Water Quality Control Program authorized by the Legislature in 1965. This study is being conducted by the State Water Resources Control Board and the results are to be presented to the Legislature early in 1969. To the extent that any facility of the State Water Project contributes to the pollution of any waters, the Department has and will participate with other contributors to assess and correct or prevent the problem.

No. 5: It is recognized that certain conclusions may have been drawn from material outside of that appearing within the report. However, this one is not supported by facts. Reference is made to a presentation by Raymond Walsh, Project Director, San Francisco Bay-Delta Water Quality Control Program, to the Advisory Water Commission of San Joaquin County Flood Control and Water Conservation District, August 28, 1968, Stockton, California. It points out that for outflows up to 4,000 cfs, discharge of San Joaquin agricultural drainage has a beneficial effect on TDS concentrations. The statement that the effect of nutrients will be to further tax the assimilative capacity, cannot be stated as a certainty.

No. 6: We agree that construction of a Peripheral Canal to bypass the Delta is necessary to negate the effects of increased pumping on the Delta fishery and Delta water quality.

No. 7: We agree that Peripheral Canal intake facilities, operating near design capacity, might prove a handicap to migrating fish. Consequently, studies are under way to prevent or reduce this impairment. Proper releases from the Canal will improve water quality and fish habitat in the Delta.

No. 8: We agree that the proposed widening and deepening of the navigational channels to Stockton and Sacramento may require additional outflow for the retardation of salinity intrusion. But, regardless of the outflow required, we will operate our project to meet the November 19, 1965 Delta Water Quality Criteria.

No. 9: We agree that thermal pollution, though not discussed, could reduce oxygen content, alter marine biota, and interfere with migrating fish. This is a form of pollution and comes under the jurisdiction of the Regional Water Quality Control Boards and the State Water Resources Control Board.

Recommendations

No. 1: Water quality, and not quantity, should be the primary consideration when discussing protection of the Bay and Delta area. This region has, and always will have, a large quantity of water. Thus, rather than citing specific quantities of water to protect only San Francisco Bay water quality, we believe that by maintenance of the November 19, 1965 Delta Water Quality Criteria and construction of overland water supply facilities in the extreme western Delta, the water quality and water supply of the Delta-Bay system will be protected. The Peripheral Canal is the Delta facility that will provide the greatest benefit to the Delta fishery by eliminating the effect of pumping on the Delta channels and controlling water quality.

Cooperative studies by the Departments of Water Resources and Fish and Game to preserve the wildlife resources of Suisun Marsh are under way and have been for several years. They will define the relationship between future channel salinity and soil salinity in the marsh, and the effect on waterfowl fish plants. They also will determine what effects, if any, water project operation will have on the Suisun Marsh waterfowl habitat. Results of this study are scheduled for publication by July 1, 1970.

No. 2: Some "purging" or "flushing" appears to have a beneficial effect upon the Delta and Bay. Rather than specifying flow, the effects of which are largely unknown, the desired results of such a process are spelled out in the November 19, 1965 Delta Water Quality Criteria.

No. 3: We agree that all waste loadings should be treated to the maximum extent practical. However, the Bay-Delta Water Quality Control Program is considering the level of treatment necessary for all types of waste loads. Until results are submitted to the Legislature it appears a bit premature to recommend any specific [illegible] of treatment.

No. 4: Rather than say that the Bay-Delta system should be considered a prime recreational asset, we suggest you be more positive and say it is considered a prime recreational asset.

No. 5: This recommendation is not supported by fact, but on opinion. Food and drug laws exist now, and are continually evolving, that require the use only of short half-life or biodegradable exotic chemicals.

No. 6: We agree that the Peripheral Canal should be built as soon as practical, with proper releases to Delta channels to protect Delta water quality, and to maintain and improve conditions for fish.

No. 7: We agree that fish screening and diverting devices of the latest proven design should be provided at the Hood Intake, and that the water in the Sacramento River below Hood be of adequate quality to meet all designated beneficial uses.

No. 8: We agree that model testing would be useful to study the possible effects of channel improvements on salinity intrusion.

No. 9: We agree that the effects of thermal pollution on estuarine ecology should be investigated.

No. 10: We agree, California's water resources should be properly managed. The recommendation for integrated computer control of all water projects is unrealistic. The State Water Project and the Federal Central Valley Project are under integral operation at this time, and will continue to be operated in such a manner.

No. 11: We agree that the Bay-Delta system should be and is, protected in policy and law. However, rather than citing outflow minimums, a more rational method would be to cite quality limitations such as the November 19, 1965 Delta Water Quality Criteria. Releases of stored water from upstream reservoirs have been made for water quality control and such releases will continue.

No. 12: This recommendation is totally impractical, and we are surprised the Sierra Club would even consider adopting such a statement. It fails to consider the California Constitution, legislative mandates, and the California Water Code. No area of the State can be placed in a preemptive position over another area. The waters of the State, a precious resource, must be put to beneficial use, without waste.

No. 13: We agree there should be no short-sighted exploitation of the northern watersheds. Water is extremely valuable and should be balanced among all beneficial uses. At this time, desalination is not economically competitive in any analysis.

# DELTA WATER QUALITY CRITERIA

Negotiations regarding Delta water problems have been in progress among negotiating teams representing the following groups and agencies:

Sacramento River and Delta Water Association,
representing the Delta areas shown on Plate 1
San Joaquin Water Rights Committee, representing
the Delta areas shown on Plate 2
California Department of Water Resources
United States Bureau of Reclamation

Although the negotiating teams are not authorized to commit the groups and agencies that they respectively represent, they do approve the attached proposed Delta Water Quality Criteria dated November 19, 1965, as an appropriate basis for further negotiations leading to agreements between Delta interests and the operators of the Federal and State projects affecting water supplies in the Delta which will assure the Delta area represented of a dependable supply of water of suitable quality sufficient to meet its present and future needs.

Dated: November 19, 1965

Sacramento River and Delta
Water Association

By /s/ John M. Luther

California Department of Water
Resources

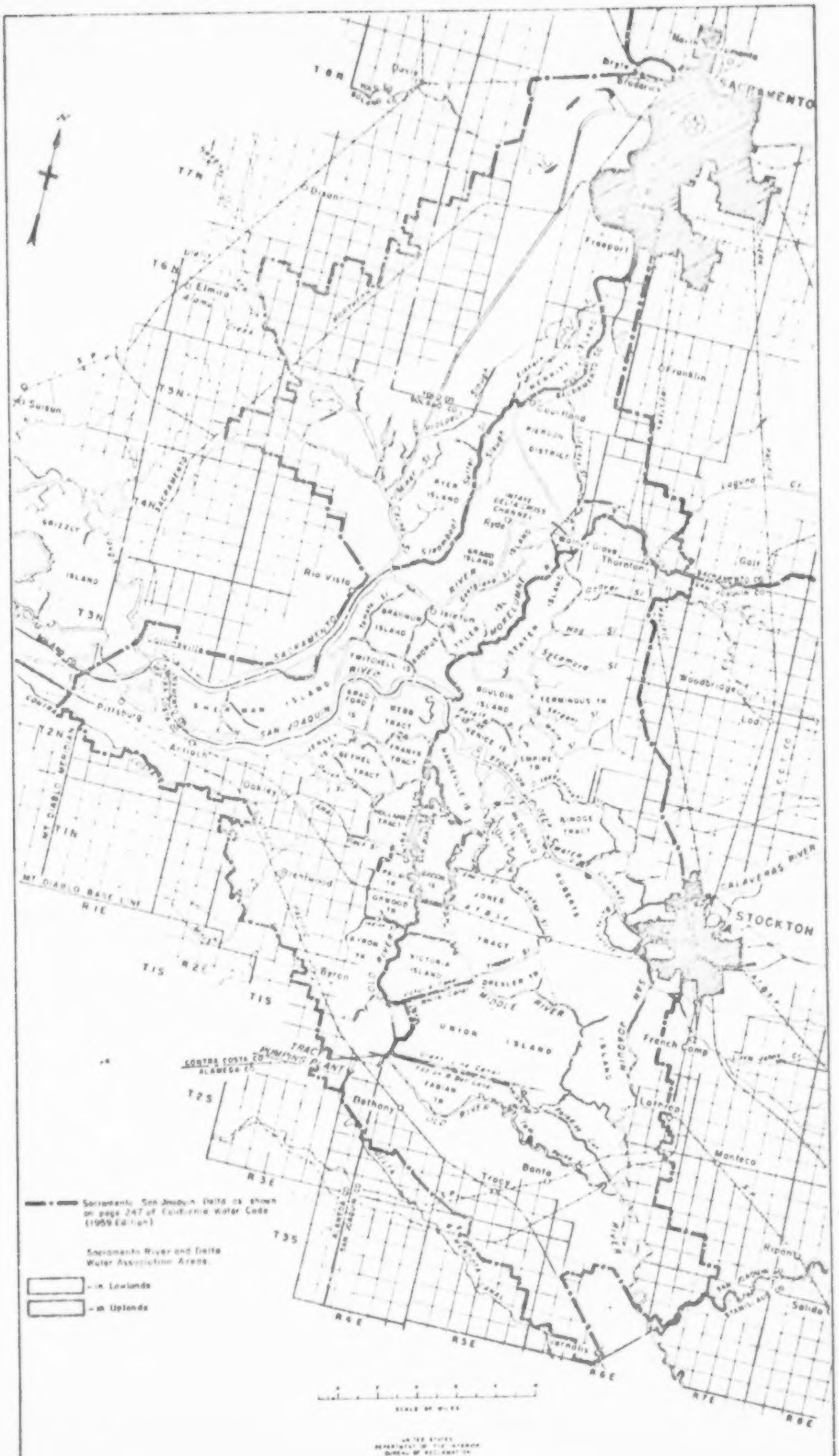
By /s/ Reginald C. Price

San Joaquin Water Rights
Committee

By /s/ John A. Wilson

United States Bureau of
Reclamation

By /s/ E. F. Sullivan


SACRAMENTO
North Sacramento
Bryte
Broderick
Davis
Dixon
Elmira
Suisun
Freeport
Franklin
Courtland
PIERSON DISTRICT
RIVER ISLAND
GRAND ISLAND
INTER DELTA CROSS CHANNEL
Ryde
Walnut Grove
Thornton
Galt
Rio Vista
GRIZZLY ISLAND
Collinsville
SACRAMENTO RIVER
SAN JOAQUIN RIVER
SHERMAN ISLAND
TWITCHELL IS.
BRANNAN ISLAND
Isleton
TYLER IS.
STATEN ISLAND
MOKELUMNE
BOULDIN ISLAND
TERMINOUS TR.
WEBB TRACT
BETHEL TRACT
VENICE IS.
EMPIRE TR.
Pittsburg
Antioch
Oakley
HOLLAND TRACT
RINDGE TRACT
Woodbridge
Lodi
Brentwood
JONES TRACT
ROBERTS
STOCKTON
CALAVERAS RIVER
Byron
VICTORIA ISLAND
DRESLER TR.
MIDDLE RIVER
UNION ISLAND
French Camp
CONTRA COSTA CO.
ALAMEDA CO.
PUMPING PLANT
Bethany
Lathrop
Banta
Tracy
Manteca
Ripon
Salida
Vernalis
MT DIABLO BASE LINE
T8N
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T5N
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R7E
R8E
Sacramento - San Joaquin Delta as shown on page 247 of California Water Code (1959 Edition)
Sacramento River and Delta Water Association Areas.
- in Lowlands
- in Uplands
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL VALLEY PROJECT
DELTA DIVISION - CALIF.

## SACRAMENTO-SAN JOAQUIN
## DELTA AREA

SEPT. 30, 1964, REV. 12-7-65

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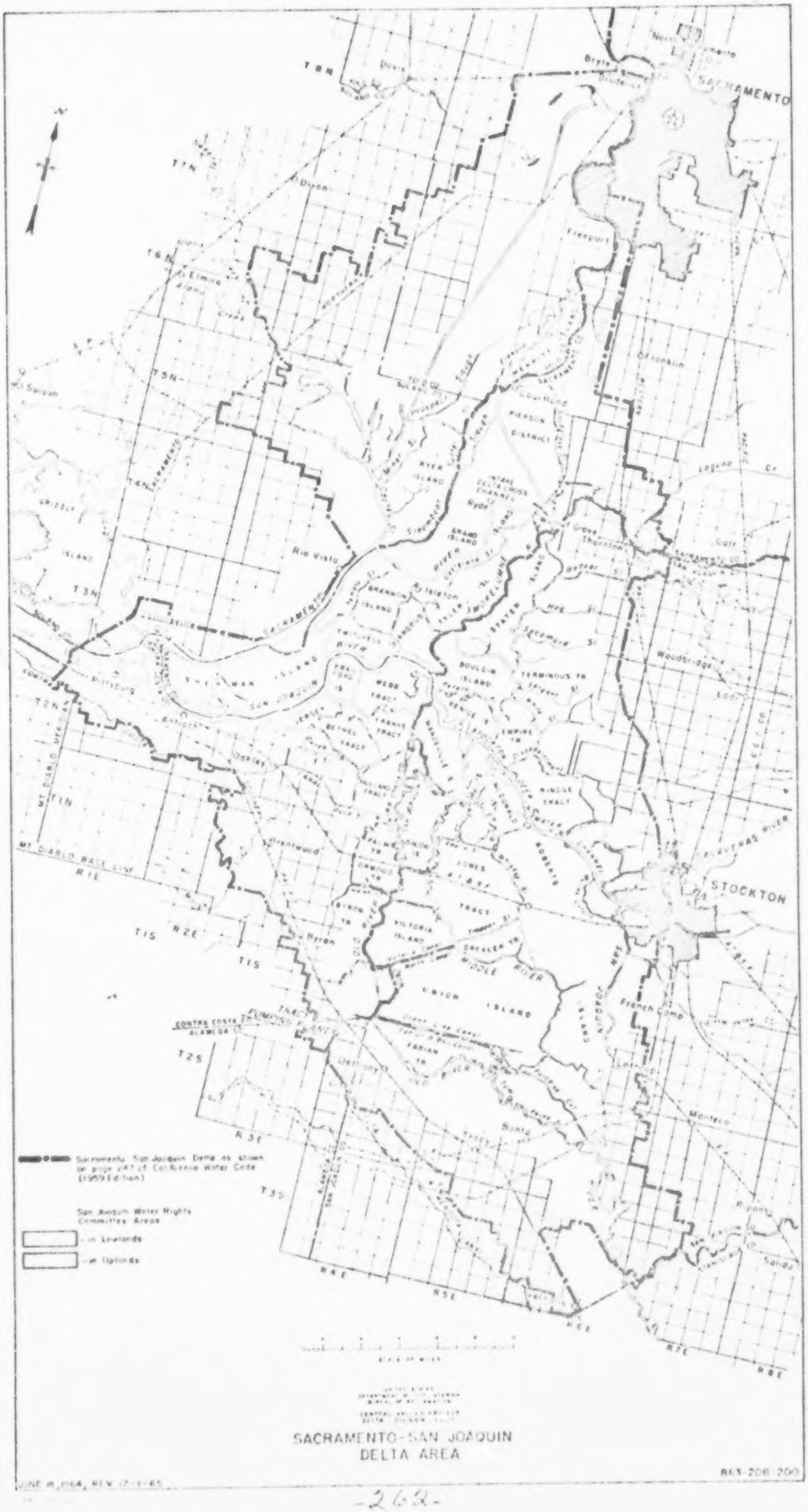

SACRAMENTO
North Sacramento
Bryte
Broderick
Davis
Dixon
Elmira
Suisun
Freeport
Franklin
Courtland
PIERSON DISTRICT
RYER ISLAND
Hood
GRAND ISLAND
Walnut Grove
Thornton
Rio Vista
Isleton
BRANNAN ISLAND
SHERMAN ISLAND
SAN JOAQUIN RIVER
Pittsburg
Antioch
Oakley
Brentwood
Byron
STATEN ISLAND
BOULDIN ISLAND
TERMINOUS TR.
Woodbridge
Lodi
WEBB TRACT
BETHEL TRACT
EMPIRE TR.
RINDGE TRACT
JONES TRACT
ROBERTS
VICTORIA ISLAND
MIDDLE RIVER
UNION ISLAND
STOCKTON
French Camp
Lathrop
Manteca
Tracy
Banta
Ripon
Salida
CALAVERAS RIVER
Mokelumne
Legend Cr.
Galt
Sacramento Co.
San Joaquin Co.
Contra Costa Co.
Alameda Co.
PUMPING PLANT
GRIZZLY ISLAND
MT. DIABLO BASE LINE
T8N
T7N
T6N
T5N
T4N
T3N
T2N
T1N
T1S
T2S
T3S
R1E
R2E
R3E
R4E
R5E
R6E
R7E
R8E
N

Sacramento-San Joaquin Delta as shown on page 247 of California Water Code (1959 Edition)

San Joaquin Water Rights Committee Areas

▭ - in Lowlands

▭ - in Uplands

SACRAMENTO-SAN JOAQUIN
DELTA AREA

JUNE 18, 1964, REV. 12-1-65

863-208-200

-262-

Bureau of Reclamation
Department of Water Resources
San Joaquin Water Rights Committee
Sacramento River and Delta Water
Association

November 19, 1965

## DELTA WATER QUALITY CRITERIA

A. Delta Area: Delta area will include both Delta lowlands and Delta uplands and may include as much but no more than the area described in Section 12220 of the Water Code of the State of California.

B. General Objectives: The general objectives of these criteria are as follows:

1. To protect the Western Delta channels against the intrusion of ocean salinity.

2. To provide water of suitable quality in the interior Delta channels acceptable for the contemplated uses.

C. Definitions: The definitions of certain terms used in these criteria are as follows:

1. "Critical year" shall mean any year in which either of the following eventualities exists:

a. The forecasted full natural inflow to Shasta Lake for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) is equal to or less than 3,200,000 acre-feet; or

November 19, 1965

b. The total accumulated actual deficiencies below 4,000,000 acre-feet in the immediately prior water year or series of successive prior water years each of which had inflows of less than 4,000,000 acre-feet, together with the forecasted deficiency for the current water year, exceed 800,000 acre-feet.

2. "Dry year" shall mean any year other than a critical year in which the forecasted full natural inflow to Shasta Lake for the current water year is equal to or less than 4,000,000 acre-feet.

3. "Below normal year" shall mean any year in which the forecasted full natural inflow to Shasta Lake for the current water year is equal to or less than 4,500,000 acre-feet but more than 4,000,000 acre-feet.

4. "Full natural inflow to Shasta Lake" shall mean the computed inflow to Shasta Lake under present water development above Shasta Lake. In the event that a major water project is completed above Shasta Lake after September 1, 1963, which materially alters the present regimen of the stream systems contributing to Shasta Lake, the computed inflow to Shasta Lake will be adjusted to eliminate the effect of such water project. After consultation with the State, the Weather Bureau, and other recognized forecasting agencies, the U. S. Bureau of Reclamation will select the forecast to be used and will make the details of

it available to the Delta water users. The same forecasts used by the United States for the operation of the Central Valley Project shall be used to make the forecasts under this agreement. Such forecasts shall be made by February 15 of each year and may be revised as frequently thereafter as conditions and information warrant.

D. Quality Criteria: The quality criteria for water in the channels of the Delta required to satisfy the general objectives set forth in Article B are as follows:

1. At Jersey Point in San Joaquin River and at Emmaton (southwest end of Horseshoe Bend) in Sacramento River, a mean daily chloride content of 1,000 parts per million or less when measured on the basis of the average mean daily value for any 10 consecutive days, except that after August 1 of a critical year and until December 31 of the same calendar year, the quality criteria set forth above may be increased from 1,000 parts per million to 1,400 parts per million of chloride.

2. At Jersey Point in San Joaquin River and at Emmaton in Sacramento River, an average mean daily chloride content of 200 parts per million or less for a period of at least 10 consecutive days each year at some time during the period between April 1 and May 31, except in dry or critical years.

November 19, 1965

3. At Terminous in Little Potato Slough, at Rio Vista in Sacramento River, at San Andreas Landing in San Joaquin River, at Clifton Court Ferry in Old River, and after the initial operation of the Peripheral Canal, at the bifurcation of Middle River and Old River,

a. A mean daily total dissolved solids content of 700 parts per million or less when measured on the basis of the average mean daily value for any 10 consecutive days,

b. A mean monthly total dissolved solids content of 500 parts per million or less when measured on the basis of the average mean daily value for any calendar month,

c. A mean annual total dissolved solids content of 450 parts per million or less when measured on the basis of the average mean daily value for any calendar year.

4. After April 1 in a dry or critical year and after August 1 in a below normal year and until December 31 of the same calendar year, the total dissolved solids criteria specified in Article D, Part 3, may reach, but not exceed, 800 parts per million for item a, 600 parts per million for item b, and 500 parts per million for item c; provided, however, the average of the values of the total dissolved solids content at all of the named locations shall not exceed, for the balance of the calendar year, the mean values specified in Article D, Part 3.

November 19, 1965

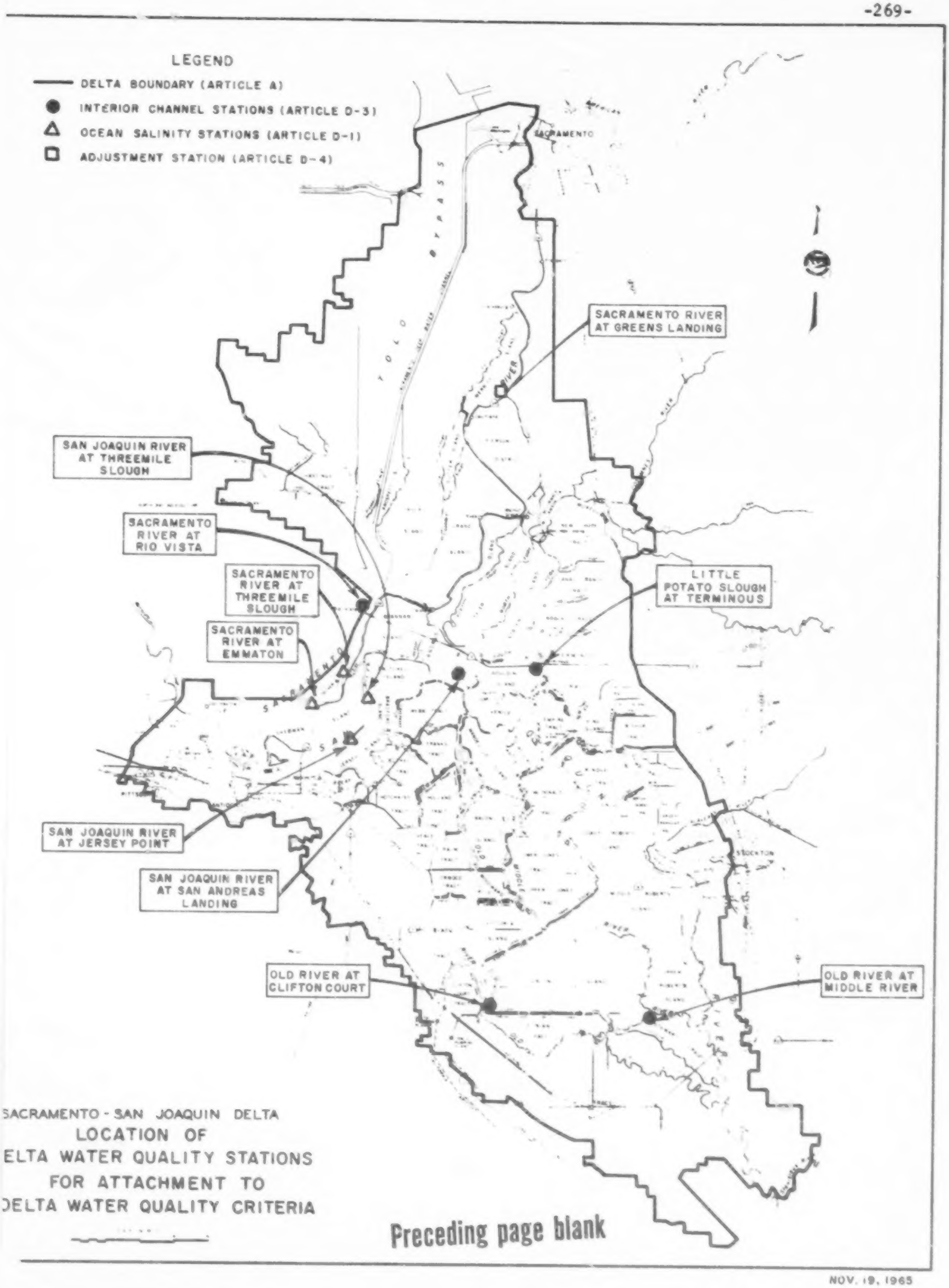
5. Whenever the recorded total dissolved solids content in Sacramento River at Green's Landing exceeds a mean 10-day or a mean monthly value of 150 parts per million, the quality criteria in Article D, Parts 3 and 4 may be changed by adding to those values the product of 1-1/2 times the amount by which the recorded total dissolved solids content at Green's Landing exceeds 150.

E. Conditions Permitting Change of Location of Control Stations at Emmaton and Jersey Point: After 1980, the locations of the control stations at Emmaton and Jersey Point may be moved upstream to, but not beyond, (1) the south end of Threemile Slough in San Joaquin River and (2) the north end of Threemile Slough in Sacramento River and substitute water facilities provided for the area affected by such move, if the parties agree that operating experience indicates that the water quality criteria specified in Article D, Part 1 will create undue hardship to the operators of the State or Federal projects, and agree upon terms and conditions as may be authorized by law and mutually agreeable to the parties at that time; provided, however, nothing in this agreement shall be construed to waive whatever rights the project operators may otherwise have to provide in the public interest a substitute water supply in lieu of the water supply provided by these criteria subject to applicable law including the obligations of the State under Sections 12200-12205 of the Water Code.

After 1980, if operating experience indicates that the water quality criteria specified in Article D is creating undue hardship to the Delta water users, the quality of the water may be improved if the parties so agree, and then upon such terms and conditions as may be mutually agreeable to the parties.

F. Peripheral Canal and Other Projects: The proposed Peripheral Canal, and any other projects of the United States or the State of California, will be operated in such a manner so as not to violate the foregoing objectives. Flows in Sacramento River and releases from Peripheral Canal into Delta channels will be in such quantities and at such locations as will provide the best quality of water over the Delta as a whole and specifically not less than the quality provided in Article D.

G. New Melones: In the event New Melones Reservoir on Stanislaus River is operated to provide water quality control, the quality of the water in San Joaquin River at Vernalis will be maintained at 500 parts per million of total dissolved solids content or less, when measured on the basis of the average mean daily value for any 30 consecutive days, provided that not more than 70,000 acre-feet shall be released from New Melones Reservoir in any one calendar year specifically for water quality, in addition to the water released for fishery and other purposes and downstream prior rights.


LEGEND
DELTA BOUNDARY (ARTICLE A)
● INTERIOR CHANNEL STATIONS (ARTICLE D-3)
△ OCEAN SALINITY STATIONS (ARTICLE D-1)
☐ ADJUSTMENT STATION (ARTICLE D-4)
SACRAMENTO
YOLO BYPASS
RIVER
SACRAMENTO RIVER AT GREENS LANDING
SAN JOAQUIN RIVER AT THREEMILE SLOUGH
SACRAMENTO RIVER AT RIO VISTA
SACRAMENTO RIVER AT THREEMILE SLOUGH
SACRAMENTO RIVER AT EMMATON
LITTLE POTATO SLOUGH AT TERMINOUS
SACRAMENTO
SAN
SAN JOAQUIN RIVER AT JERSEY POINT
SAN JOAQUIN RIVER AT SAN ANDREAS LANDING
STOCKTON
RIVER
OLD RIVER AT CLIFTON COURT
OLD RIVER AT MIDDLE RIVER

SACRAMENTO - SAN JOAQUIN DELTA
LOCATION OF
ELTA WATER QUALITY STATIONS
FOR ATTACHMENT TO
DELTA WATER QUALITY CRITERIA

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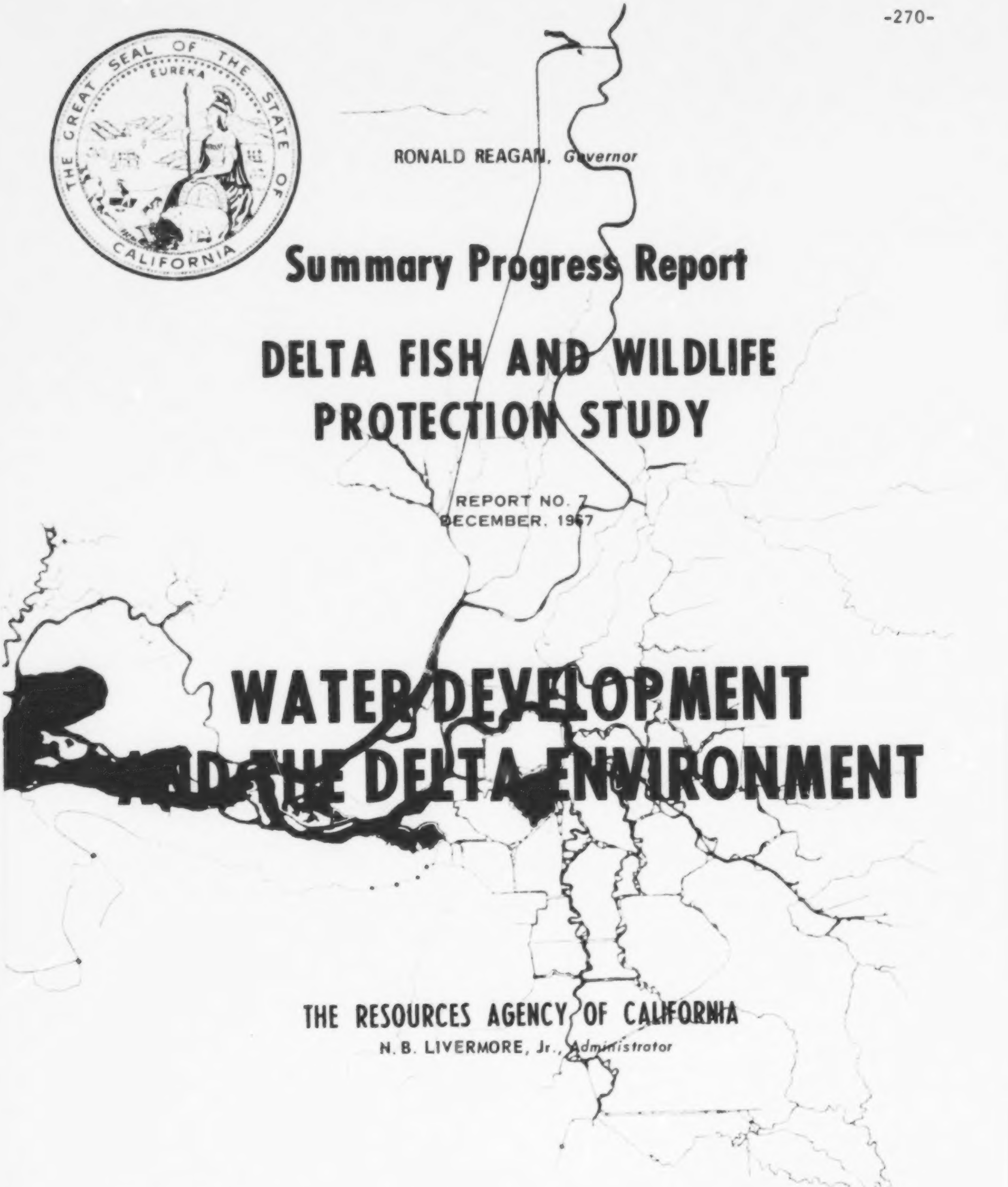
NOV. 19, 1965



RONALD REAGAN, Governor

# Summary Progress Report

# DELTA FISH AND WILDLIFE PROTECTION STUDY

REPORT NO. 7
DECEMBER, 1967

# WATER DEVELOPMENT AND THE DELTA ENVIRONMENT

THE RESOURCES AGENCY OF CALIFORNIA
N. B. LIVERMORE, Jr., Administrator

WALTER T. SHANNON
*Director*
Department of Fish and Game

WILLIAM R. GIANELLI
*Director*
Department of Water Resources

State of California
THE RESOURCES AGENCY

Summary Progress Report
Delta Fish and Wildlife Protection Study
Report No. 7

# WATER DEVELOPMENT AND THE DELTA ENVIRONMENT

A Cooperative Study
by the
Department of Fish and Game
and the
Department of Water Resources

December 1967

# ACKNOWLEDGMENTS

Special mention for assistance and advice is made to Don Kelley of the Department of Fish and Game and Wesley Steiner of the Department of Water Resources who made many helpful suggestions for content, organization, and accuracy of the report.

# FOREWORD

The water and the fishery resources of California belong to all of the people of our great State. Our very existence, physical well-being, and economy depend on water. Moreover, much of our recreation and economy depend on fish and the habitat that supports them. For fullest benefit to the people, both of these resources must be managed in a well-balanced program by the State Departments of Water Resources and Fish and Game.

The Sacramento-San Joaquin Delta is one of the most important areas in California to the conservation and development to these two vital resources. In 1961, the State Departments of Water Resources and Fish and Game, recognizing that the State Water Project would have a major impact on the Delta environment for fish and wildlife, initiated the Delta Fish and Wildlife Protection Study. This report brings together under one cover a summary of the more important findings to date relative to the State Water Project, the selection of the Peripheral Canal Plan, and the water entitlement agreements negotiated with local Delta interests. It sets forth a measure of the aquatic life and the general concept for operation in relation to these agreements; reports how fish and other aquatic life are affected by present Delta water operations; and explains how and why the Peripheral Canal, properly operated, can enhance as well as protect the fishery resources.

One central theme stands out. This is the importance of maintaining and improving the Delta environment for fish and other aquatic life while meeting California's water development needs. In meeting this objective, the Peripheral Canal Plan is enthusiastically supported by the California Department of Fish and Game and the U. S. Fish and Wildlife Service.

Accomplishment of the broad goals of protection and enhancement of the Delta's aquatic resources embraces a host of individual objectives. Many of those proposed or recommended by the fish and game agencies are discussed in this report. Some will be achieved automatically with construction and operation of the Peripheral Canal. Others, however, require further study and operating experience to evaluate the practical extent to which each of these objectives can be accomplished by the project and to formulate appropriate operating criteria.

The establishment of additional water quality criteria at this time could restrict a meaningful operating agreement between the Department of Fish and Game and the project operators, and even negate the fishery enhancement potential of the project. Additional studies are required before specific operating criteria are established.

William R Gianelli
William R. Gianelli, Director
Department of Water Resources
State of California
December 1967

WTShannon
Walter T. Shannon, Director
Department of Fish and Game
State of California
December 1967

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME
DEPARTMENT OF WATER RESOURCES

RONALD REAGAN, Governor, State of California
N. B. LIVERMORE, Administrator, Resources Agency
WALTER T. SHANNON, Director, Department of Fish and Game
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## SUMMARY AND CONCLUSIONS

The Sacramento-San Joaquin Delta is the single most important area in California from the standpoint of conservation and combined development of two vital resources -- water and fishlife.

The Delta lies at the confluence of the Sacramento and the San Joaquin Rivers, which together contribute almost one-half of the full natural runoff of the State. It covers 738,000 acres. It is the common point of collection and diversion to achieve one of the major objectives of the California Water Plan -- that of conserving and transporting the State's surplus waters of the north to meet the fast-growing water needs to the south and west.

The Delta's 700 miles of meandering waterways form a unique aquatic environment for the greatest variety of fish and other aquatic life in California. Salmon, striped bass, shad, catfish, and sturgeon represent the more important game fish species. In fact, about 25 percent of all warmwater and anadromous sportfishing in California, and about 80 percent of California's commercial salmon fishing are dependent on the Delta estuary in one way or another.

Environmental conditions for fish and other aquatic life have deteriorated in the Delta due to man's activities. Adverse conditions are due largely to upstream water development, coupled with the impact of increasing federal and state water transfer and export pumping from the southern channels. Localized waste discharges compound the problem.

As a result, there is at present: interference with migration of salmon and other anadromous fish; loss of striped bass spawning areas in the southern channels; loss of large numbers of striped bass eggs and larvae which pass through louver fish screens into the export pumps; decreases in aquatic fish food supply in the Delta channels that are used for water transfer; and great variation in the quantity of important fish food available in the western Delta and the adjoining bays where extreme and sudden changes in salinity now occur.

Plans for correcting these and other problems associated with fish and the aquatic environment are discussed in this report. These plans are the result of a comprehensive cooperative study initiated in 1961 by the Department of Fish and Game and the Department of Water Resources. This study was designed to determine how to protect the fish and wildlife resources of the Delta, in a manner compatible with construction and operation of the State Water Project. To date, over $2.5 million has been invested in the program. Of this, about 2/3 was devoted to biological investigations and analyses and about 1/3 to related engineering studies.

The results of the studies that have been published to date are contained in six annual reports and in two fish bulletins. The annual reports contain a general account of the investigational procedures and findings as the studies progressed. The technical aspects of the ecological studies are contained in Fish Bulletins Nos. 133 and 136. These and other references related to project planning and fish and wildlife considerations are listed in the bibliography to this report. The inherent opportunities for restoring and enhancing Delta fish and wildlife, determined by that study, were major considerations in selecting the Peripheral Canal as a joint state-federal facility over all other alternative plans for water transfer through the Delta.

The Peripheral Canal Plan is the only plan studied that can distribute a freshwater supply to the interior Delta, and at the same time provide a positive downstream net flow through all main Delta channels to San Francisco Bay. By changing the diversion point for export to the head of the Peripheral Canal, the impact of water transfer and pumping from the southern Delta on fish and other aquatic life will be eliminated. The Peripheral Canal was found to be the only plan that can protect the fish and aquatic resources of the Delta and also provide opportunities for their enhancement.

The Peripheral Canal will convey water for state and federal water projects around the eastern edge of the Delta in a new, 43-mile channel, hydraulically isolated from existing Delta channels. It will be siphoned under the three major stream crossings -- the Mokelumne, the San Joaquin, and Old Rivers -- to allow for flood passage, fish migration, and navigation. Fish will be screened at the headworks on the Sacramento River near Hood. Releases will be made at slough and river crossings to supply fresh water for agricultural use, water quality control, and aquatic life.

Salmon will benefit from improved conditions during their peak migration periods. A flow-reversal problem will be eliminated and positive net downstream flows will be maintained in most all Delta channels. This will help prevent the buildup of salts and pollutants and reduce dissolved oxygen sags. A higher proportion of home-stream water in the migration channels will help guide migrating fish to their spawning beds.

Striped bass will benefit from improved conditions, particularly at spawning times. The problem of egg and larvae loss into the pumps will be greatly reduced. Areas with flow and quality conditions presently unsuitable for spawning in the southern and eastern Delta will be made suitable.

Catfish and other warmwater fish, which favor quiet water, will benefit from a reduction in net flow in the present water transfer channels.

The joint-use Peripheral Canal will be operated in conjunction with the reservoirs of the Federal Central Valley Project and the State Water Project, to guarantee the requirements of the November 19, 1965 Delta Water Quality Criteria, negotiated with local interests by the Department of Water Resources and the U. S. Bureau of Reclamation. Final operational criteria of the Peripheral Canal for fish and aquatic life have not been set. Waterflow characteristics, including quantity, quality, velocity, temperature, and direction of net flow, directly influence the aquatic environment. The cooperative studies by the Department of Fish and Game and the Department of Water Resources are continuing with the goal of establishing the distribution and schedules of releases from the Canal for these purposes.

Adequate knowledge for meeting the environmental objectives for fish and other aquatic life is not yet available to establish firm operating criteria for the Peripheral Canal. However, the water quality criteria in the November 19, 1965 water entitlement agreement provides a framework within which most, and perhaps all, environmental objectives may be attained. More precise information is needed concerning the factors controlling dissolved oxygen, the time and location of striped bass spawning, and the maintenance of an adequate population of *Neomysis* to supply food for juvenile bass. Such information is essential both to develop a specific canal-operating schedule for aquatic resources and to relate these criteria to project capability. Considerable effort is being directed toward this end in the cooperative study program of the two departments. Also, it is intended that a meaningful period of trial operation be carried out to assure the desired results before final operating criteria are adopted. The establishment of additional water quality criteria could restrict the operating flexibility of the Peripheral Canal and could prove to be a serious impediment to the development of an operating agreement to accomplish the fish and wildlife objectives of the project.

## Conclusions

The major conclusions to date resulting from project planning and fish and wildlife studies of the Delta are summarized below:

1. At present, fish and other aquatic life are adversely affected by export pumping, localized waste discharges, and upstream water developments;

2. Without remedial measures, adverse conditions will worsen, coincident with increased export for authorized units of the federal and state projects;

3. State and federal legislation require protection and consideration of enhancement of fishery resources in connection with the state and federal water projects, and the overall water conservation and development needs of the State;

4. A joint state-federal Peripheral Canal offers the best opportunity to restore and enhance the Delta's aquatic environment and fishlife;

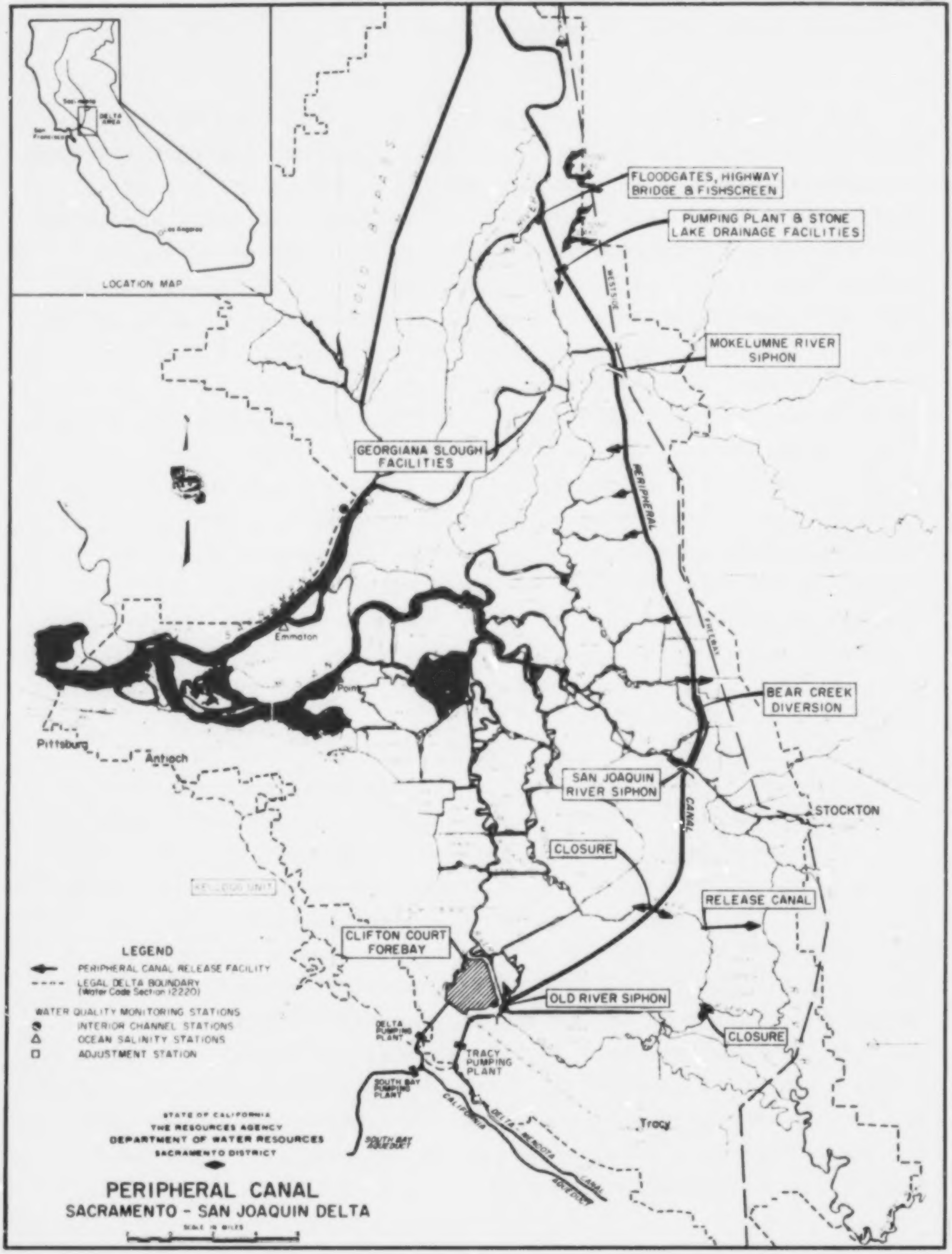
5. The Peripheral Canal should be constructed at the earliest possible date;

6. The November 19, 1965 Delta Water Quality Criteria, together with overland water facilities in the western Delta, are appropriate and necessary measures for carrying out the California Water Plan;

7. Work to date indicates that the Peripheral Canal and the November 19, 1965 Delta Water Quality Criteria permit substantial operational flexibility to accomplish most, and perhaps all, environmental needs of fish and other aquatic life;

8. It is important to maintain operational flexibility. Studies of factors controlling dissolved oxygen, striped bass spawning, and food sources for sustaining young bass need to be completed and operational experience gained to assure that the opportunity to protect and enhance the Delta's fishery resource becomes a reality; and

9. No one environmental factor should be considered in isolation. Establishment of additional water quality criteria could preclude operation of the Peripheral Canal to protect and enhance fish and aquatic life, in balance with the overall development needs for California's water resources.


Sacramento
DELTA AREA
San Francisco
Los Angeles
LOCATION MAP
YOLO BYPASS
RIVER
FLOODGATES, HIGHWAY BRIDGE & FISHSCREEN
PUMPING PLANT & STONE LAKE DRAINAGE FACILITIES
WESTSIDE
MOKELUMNE RIVER SIPHON
GEORGIANA SLOUGH FACILITIES
PERIPHERAL
Emmaton
Point
Pittsburg
Antioch
EASTBAY
BEAR CREEK DIVERSION
SAN JOAQUIN RIVER SIPHON
CANAL
STOCKTON
CLOSURE
KELLOGG UNIT
RELEASE CANAL
CLIFTON COURT FOREBAY
OLD RIVER SIPHON
DELTA PUMPING PLANT
CLOSURE
TRACY PUMPING PLANT
SOUTH BAY PUMPING PLANT
SOUTH BAY AQUEDUCT
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PERIPHERAL CANAL RELEASE FACILITY
LEGAL DELTA BOUNDARY (Water Code Section 12220)
WATER QUALITY MONITORING STATIONS
INTERIOR CHANNEL STATIONS
OCEAN SALINITY STATIONS
ADJUSTMENT STATION
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SACRAMENTO DISTRICT
SCALE IN MILES

PERIPHERAL CANAL
SACRAMENTO - SAN JOAQUIN DELTA

# INTRODUCTION

The Sacramento-San Joaquin Delta is located at the confluence of the south-flowing Sacramento River and the north-flowing San Joaquin River which together drain the Central Valley of California. These two rivers turn westward at the Delta and unite near the City of Pittsburg and discharge their flows by way of Suisun, San Pablo, and San Francisco Bays into the Pacific Ocean. Together they drain about 37 percent of the total land area of the State of California (refer to inset map, Plate 1). These rivers contribute more than 47 percent of the full natural runoff of the State which, without development, control, and utilization, would find its way to the Pacific Ocean.

The Delta encompasses about 738,000 acres and is interlaced with about 700 miles of waterways covering 50,000 acres. These waterways meander among more than 50 intensively farmed islands and tracts, many of which are below sea level. About 415,000 acres of land in the Delta, commonly known as the Delta lowlands, lie between elevations 5 feet above and 20 feet below mean sea level, and are protected from floodwater and high tides by manmade levees (refer to Plate 1).

The Sacramento-San Joaquin Delta is one of the most important areas in California from the viewpoint of the conservation and development of two vital resources -- water and fish. In 1961, the State Departments of Water Resources and Fish and Game, recognizing that the State Water Project would have a major impact on the Delta environment for fish and wildlife, initiated the Delta Fish and Wildlife Protection Study. It was designed to determine how to protect and, where feasible, enhance the fish and wildlife resources of the Delta, in a manner compatible with construction and operation of the State Water Project. To date, over $2.5 million has been invested in the program. Of this, about two-thirds was devoted to biological investigations and analyses and about one-third to related engineering studies. This report brings together under one cover a summary of the more important findings to date relative to water development, the Delta environment, and the effects on fish and other aquatic life.

The results of the studies that have been published to date are contained in six annual reports and in two fish bulletins. The annual reports contain a general account of the investigational procedures and findings as the studies progressed. The technical aspects of the ecological studies are contained in Fish Bulletins Nos. 133 and 136. These and other references related to project planning and fish and wildlife considerations are listed in the bibliography to this report. The inherent opportunities for restoring and enhancing Delta fish and wildlife, determined by that study, were major considerations in selecting the Peripheral Canal as a joint state-federal facility over all other alternative plans for water transfer through the Delta.

## Fishery Resources

The Delta provides a unique and varied environment essential for the maintenance of a large segment of California's fishery resources and other aquatic life. Its importance is illustrated by the fact that an estimated population of 4 to 8 million adult striped bass is dependent on this environment during much of the year. About 60 percent of this population spawns in the Delta channels each spring, with most of the remainder spawning in the Sacramento River upstream from Hood. Delta waters also supply a vital nursery area for juvenile striped bass.

Other fishery resources dependent on the Delta include spawning runs of up to 500,000 king salmon, 100,000 steelhead, and 2 million American shad. These pass through the Delta annually on their spawning migrations. In addition, the Delta affords a habitat for sturgeon, and large populations of resident game fishes, such as catfish, black bass, and crappie.

Delta waters also provide a vital source of aquatic food, such as: zooplankton, those microscopic animals in the water which are eaten by fish larvae and fry; neomysis, a tiny shrimp which sustains fish too large to maintain themselves on zooplankton until they are large enough to eat smaller fish; and benthos, those bottom-living animals such as clams, worms and insects which support catfish and sturgeon. These food sources are necessary to the survival of the Delta fishery.

It is estimated that Delta fish populations presently support 3 million angler-days of sportfishing annually. By 1980 this use is expected to increase to at least 5 million angler-days. The value of such a sport fishery to the State's economy and the well-being of its citizens is obvious.

The ocean commercial salmon catch averages 8 million pounds annually and is supported largely by runs migrating through the Delta and spawning in the Sacramento and San Joaquin River systems. This catch furnished a net annual income to the fishermen of over $3 million. It can only be maintained if adult salmon bound for upstream spawning areas and their progeny migrating downstream can pass unharmed through the Delta.

## Water Development

The Delta is the common point of collection and diversion to achieve the major objective of the California Water Plan -- that of adjusting the areal imbalance of California's water resources and needs. Implementation of the State Water Project, expansion of the Federal Central Valley Project, and continuation of individual upstream water development projects in the Central Valley, will result in significant environmental changes in the Delta estuary. Such changes include a reduction in uncontrolled winter and spring flood runoff through the Delta and also changes in the Delta's hydraulic and water quality characteristics.

The 1966 transfer through Delta channels for the Federal Central Valley Project was 1.6 million acre-feet. Annual water transfer across the Delta for export with the State Water Project and new units of the Central Valley Project will increase dramatically, to 4.6 million acre-feet by 1976, and later, to 7.8 million acre-feet.

## Elements of Acceptable Solution

Water development affecting the Delta must:

(1) Provide for meeting the Delta water requirements and environmental needs, including the protection of fish and other aquatic life; and

(2) Be compatible with statewide water development as a whole so that present and future upstream and export water requirements can be met.

## The Peripheral Canal Plan

The primary purposes of the Peripheral Canal are to convey surplus water from the Sacramento River to the state and federal pumping plants in the southern Delta and, at the same time, to serve and protect the Delta. The Canal will be a state-federal joint-use facility. It will be the Delta link in both the California State Water Project and the Federal Central Valley Project.

The principal features of the Peripheral Canal are shown on Plate 1. The Canal will be 43 miles long, about 30 feet deep, and over 400 feet wide at maximum water surface. It will be an unlined canal, hydraulically isolated from all of the Delta channels except for the intake from the Sacramento River at Hood, 20 miles below Sacramento. From Hood, it will be routed to the west of Stockton, then will continue southwesterly across the southern Delta. The Canal will be siphoned under the three major stream crossings -- the Mokelumne, San Joaquin, and Old Rivers -- to allow for flood passage, fish migration, and navigation. On the west side of Old River, the Canal will divide into two branches -- the south branch terminating at the Bureau's Tracy Pumping Plant intake canal, and the west branch terminating at the State's Clifton Court Forebay to the Delta Pumping Plant of the California Aqueduct. The capacity at the headworks will be approximately 22,000 second-feet and the terminal capacity will be about 18,000 second-feet.

Fish screening facilities will be installed at the Peripheral Canal headworks and provisions will be made to prevent downstream migrant adult fish from being trapped in front of the trashracks. A fish screen bypass, which will return salvaged fish to the Sacramento River, will be designed to minimize predation of the salvaged fish.

Just below the diversion works and fish facilities, a pumping plant will lift the water a maximum of 10 feet, and from there it will flow by gravity to the state and federal pumps. Water release structures will be located at slough and river crossings along its route to supply fresh water for agriculture, water quality control, and aquatic life.

The Peripheral Canal Plan is the only plan available that can distribute a freshwater supply to all parts of the interior Delta, and at the same time provide a positive downstream flow through Delta channels to San Francisco Bay.

## November 19, 1965 Delta Water Quality Criteria

Both the U. S. Bureau of Reclamation and the Department of Water Resources plan to operate the joint-use Peripheral Canal, in conjunction with the reservoirs of the Federal Central Valley Project and the State Water Project, so as to meet the requirements of the November 19, 1965 Delta Water Quality Criteria which have been negotiated with local Delta interests. Water rights for the State Water Project are conditioned on meeting these criteria (Water Rights Board Decision D-1275). Furthermore, it is probable that the permits for the Central Valley Project will also be conditioned to these criteria since the State Water Rights Board has retained continuing jurisdiction over salinity control in the permits for that Project (Water Rights Board Decision D-990).

Briefly, these criteria provide that salinity intrusion will be prevented from exceeding 1,000 ppm chlorides in the Sacramento River at Emmaton and in the San Joaquin River at Jersey Point. This is essentially equal to the maximum extent to which salinity intrusion now occurs incidental to transporting and protecting the quality of water pumped at the intakes to the Delta-Mendota and Contra Costa Canals of the Federal Central Valley Project. There are relaxations in certain dry years that are analogous to a deficiency in water deliveries taken by other project beneficiaries in such years. The criteria also provide for springtime flushing flows to limit salinity intrusion from exceeding 200 ppm of chlorides for at least a consecutive 10-day period during April or May in all but dry or critical years. Furthermore, the criteria specify quality limits at specific locations for the interior Delta channels that will assure Delta water users of irrigation water of adequate quality.

The location of the Delta water quality stations specified under these criteria is shown on Plate 1. Under the provisions of Section 12202 of the State Water Code, the Department of Water Resources plans to provide for a firm high-quality water supply to the western Delta agricultural areas through overland facilities where salinity control releases do not now provide acceptable water quality in the adjacent channels.

Releases from the Peripheral Canal into Delta channels to supply local needs and to control water quality and salinity intrusion will play the dual role of protecting and enhancing the Delta environment for fish and other aquatic life. While the criteria were negotiated with local agricultural interests, the Department of Water Resources had protection of aquatic life as one of the important objectives.

## PRESENT ENVIRONMENTAL CONDITIONS

Environmental conditions in the Delta can be improved substantially for fish and other aquatic life. The present adverse conditions are due primarily to upstream water development in the San Joaquin River system and to the influence of the federal and state export pumping plants, which now export over 2 million acre-feet of water annually. Under the present method of water transfer, export pumping causes an unnatural or "reverse-flow" pattern in the western and southern Delta channels. Waste discharges, the effects of which are made more acute by low river flow and flow reversal from pumping, cause dissolved oxygen sags in the San Joaquin River near Stockton. In addition, a large percentage of "home-stream" water released from upstream water projects on the San Joaquin River and its tributaries is diverted directly to the export pumping plants upon reaching the Delta.

Collectively, the foregoing conditions:

1. Interfere with the salmon migrating through the Delta. A substantial portion of the juvenile salmon migrating seaward are drawn toward the pumps. Louver screening facilities are provided to salvage fish but are not completely effective. The process of loading, transporting, and releasing fish collected at the screens results in further mortality. The annual upstream spawning runs of the San Joaquin River have decreased from approximately 50,000 fish to less than 3,000 salmon in 1961 and 1962. This decline was concurrent with the increased pumping and flow reversals. With increased export of the state and federal projects, the entire salmon run of the San Joaquin River system will be lost if the reverse-flow condition is not eliminated. The cross-Delta transfer of water also affects Sacramento River salmon adversely.

2. Draw large numbers of free-floating striped bass eggs and larvae through the louver screens into the export pumps. The Department of Fish and Game has estimated that 50 to 80 percent of all the striped bass eggs spawned in the Delta could eventually be lost by increased water export if they are not protected. Large numbers of American shad, catfish, and other fishes are also lost through the pumps.

3. Decrease fish food supply in the Delta channels used for water transfer. The high net velocity of the water transfer channels together with the relatively sterile water from the Sacramento River has decreased the production of food organisms important to the survival of most Delta fish. The residence time of the water is too short and the dissolved minerals and nutrients too low for these organisms to flourish. Figure 1 illustrates this condition by showing the density of crustacean zooplankters with water of different quality characteristics, through a wide range of net velocities. The figure was constructed by separating sloughs containing San Joaquin River water from those containing Sacramento River water, because the two waters contain very different nutrient supplies, and the total dissolved solids of San Joaquin River water are always several times higher than Sacramento River water. Figure 2 illustrates the effect of these relationships on the relative abundance of zooplankton in the Delta. In the Sacramento River and the north Delta water transfer channels, the combinations of low-nutrient water and high velocities resulted in low zooplankton production. Zooplankton populations were low in the San Joaquin River south of Stockton, in spite of the high nutrient supplies in the Stockton sewage outflow and return agricultural drains in the San Joaquin Valley because net velocities were too high for zooplankton production. Where this high-nutrient water entered the wide ship channel below Stockton, and the velocity decreased, zooplankton populations flourished.

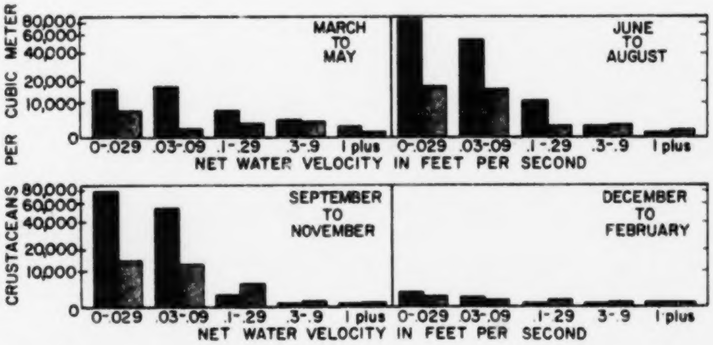

FIGURE 1. Average numbers of crustacean zooplankters each season in various rivers in the Delta at different net water velocities. Solid columns indicate plankters collected in the San Joaquin River and the stippled columns the plankters collected in the Sacramento-Mokelumne Rivers. Greater concentrations of crustaceans in the San Joaquin River reflect the higher levels of total dissolved solids in this stream. Illustration taken from Figure 5, page 100, "Fish Bulletin 133, Ecological Studies of the Sacramento-San Joaquin Estuary".

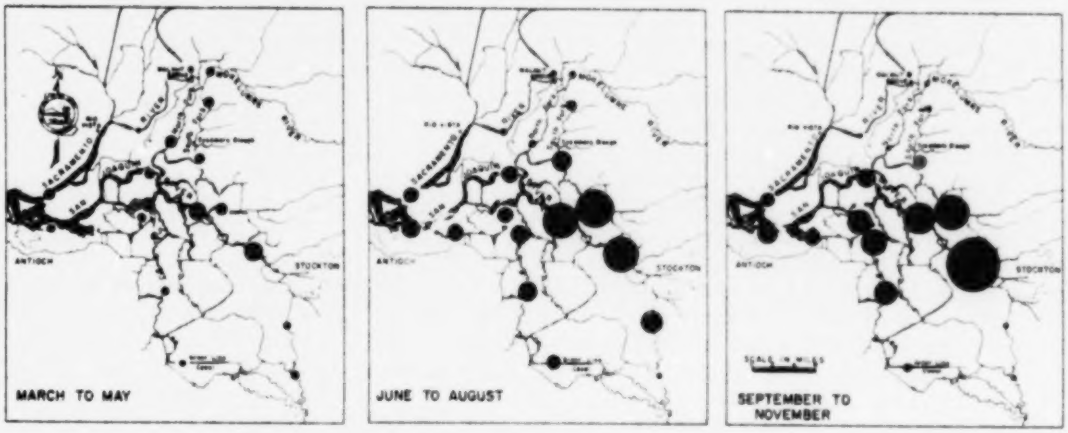

FIGURE 2. Concentration of crustacean zooplankters in the Delta during 1963. The area of each circle is proportional to the concentration of zooplankters at each station with the largest circle equal to 120,000 per cubic meter. Illustration taken from Figure 1, page 97, of "Fish Bulletin 133, Ecological Studies of the Sacramento-San Joaquin Estuary".

Also, under present conditions, the salinity gradient varies greatly over a long distance each season as the outflow to the Bay varies from low in summer to high in winter and back to low the following summer. This causes great variation in the abundance and occurrence of marine and freshwater benthic fish food organisms such as Macoma and Photis which cannot tolerate extreme and sudden salinity changes.

These and other problems associated with fish are detailed in the annual reports and the fish bulletins of the Delta Fish and Wildlife Protection Study (refer to bibliography).

## FUTURE ENVIRONMENTAL CONDITIONS

Of the numerous plans proposed for water transfer in the Delta, the Peripheral Canal* was found by far the most beneficial to the Delta's aquatic environment and fishlife. With proper design and operation of this project, not only can the fishery resources of the Delta be protected, but they can be enhanced substantially. This section explains how and why.

The factors affecting fish in the Delta are involved and complex. Waterflow characteristics including quantity, quality, velocity, and temperature, control many aspects of fish distribution, the food chain relationships, and other biological relationships.

For this reason the Delta Fish and Wildlife Protection Study has been under way since 1961. It is a joint program conducted by the State's Departments of Fish and Game and Water Resources. The study is directed toward maintaining and improving the Delta environment for fish and other aquatic life.

First, the most numerous and important fish species of the Delta were identified. Second, the factors affecting their environment that might be altered by any of the water plans were identified. Next, specific studies and field sampling procedures were undertaken to determine the relationship of water development to significant environmental factors through the life cycle of each species.

The results, to date, of these and other studies are presented in the annual reports of the Delta Fish and Wildlife Protection Study, and in the Fish Bulletins by the State Department of Fish and Game (refer to bibliography).

These studies show that, properly operated, the Peripheral Canal will:

1. Maintain a long (about 50 miles) gradual salinity gradient for migratory game fish. Such a gradient is necessary to permit the physiological changes required

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*A summary of the fishery basis for selection of the Peripheral Canal Plan is contained in the appendix to this report.

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when a fish migrates between salt water and fresh water and to provide a suitable environment for their important food sources.

2. Prevent flow reversal in all (50 to 100 miles) of the main fish migration channels and provide a positive downstream net flow in almost all Delta channels (refer to Figure 3). This will enable anadromous fish (mainly salmon) to reach their spawning grounds without loss or undue delays and prevent the buildup of salts and pollutants.

3. Reduce to less than 10 percent the loss of striped bass eggs and larvae into the export pumps. It is important to realize that louver screening will not salvage these eggs and larvae from the diversions. Without the Peripheral Canal the present loss of from 15 to 30 percent would increase to an estimated 50 to 80 percent at the southern Delta export pumps. Loss of other fishes now occurring via the pumps would be eliminated.

4. Provide an environment conducive to good production of zooplankton -- microscopic animals of great importance as a source of food for the young of most Delta fishes. Figure 4 indicates a potential 1.5 to 2-fold increase in June when they are most needed, with the largest increases occurring in the northern and western Delta channels.

5. Provide an environment more conducive to good populations of benthic animals which provide an important source of food for catfish and sturgeon. Figure 5 indicates a significant reduction of shifting sand in channel bottoms mostly in the northern Delta below the Peripheral Canal intake.

6. Retain tidal action throughout Delta channels. This is needed:

a. For the survival of Neomysis and Corophium -- two of the most important fish foods in the Delta;

b. For the survival of striped bass eggs which would otherwise settle to the bottom, suffocate, and die; and

c. To maintain good water quality conditions, particularly high dissolved oxygen levels.

7. Provide sufficient and well-dispersed areas with TDS levels below 180 ppm during the late spring for striped bass spawning.

8. In conjunction with appropriate waste discharge controls, keep dissolved oxygen levels at a satisfactory

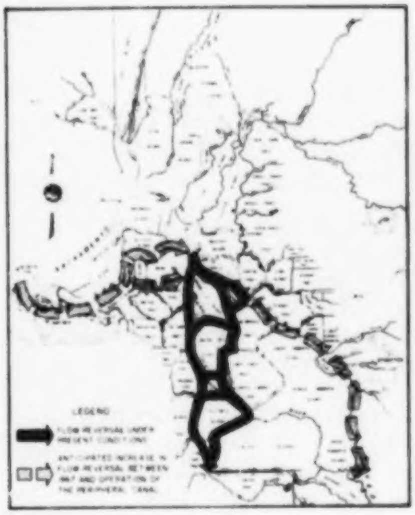
LEGEND
FLOW REVERSAL UNDER PRESENT CONDITIONS
ANTICIPATED INCREASE IN FLOW REVERSAL BETWEEN
THE PERIPHERAL CANAL

Figure 3. Channels where present and anticipated increases in flow reversal will be eliminated after operation of the Peripheral Canal. Such flow reversals interfere with both the upstream spawning migration of adult salmon and the downstream migration of young salmon. Illustration adapted from Figure 7, page 22a, "Delta Fish and Wildlife Protection Study, Report No. 3, June 1964".

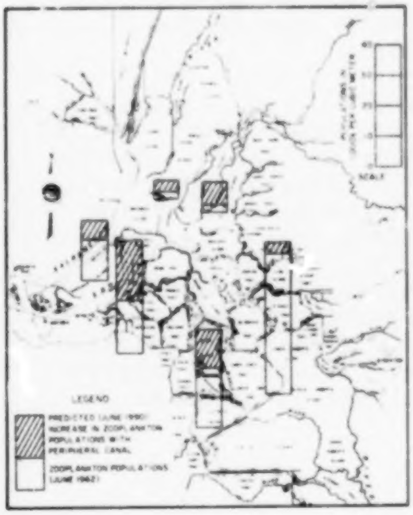
SCALE
LEGEND
PREDICTED (JUNE 1990) INCREASE IN ZOOPLANKTON POPULATIONS WITH PERIPHERAL CANAL
ZOOPLANKTON POPULATIONS (JUNE 1962)

Figure 4. Relative size of zooplankton populations in June 1962 and predicted increase in populations in June 1990 with the Peripheral Canal in operation. Illustration adapted from Figure 8, page 24a, "Delta Fish and Wildlife Protection Study, Report No. 3, June 1964".

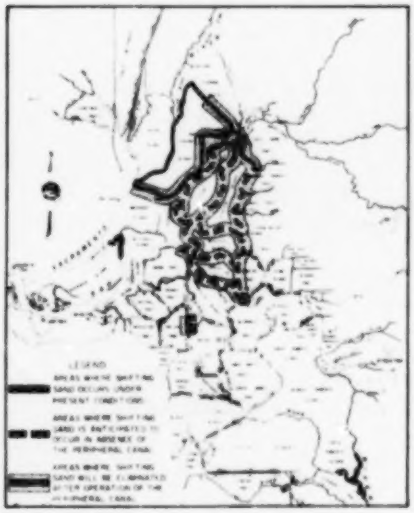
LEGEND
AREAS WHERE SHIFTING SAND OCCURS UNDER PRESENT CONDITIONS
AREAS WHERE SHIFTING SAND IS ANTICIPATED TO OCCUR IN ABSENCE OF THE PERIPHERAL CANAL
AREAS WHERE SHIFTING SAND WILL BE ELIMINATED AFTER OPERATION OF THE PERIPHERAL CANAL

Figure 5. Location of channels where shifting sand substrate, observed in 1963 and 1964, limited the production of zoobenthos; and areas where present and anticipated shifting sand substrate will be eliminated after the operation of the Peripheral Canal. Illustration adapted from Figure 9, page 26a, "Delta Fish and Wildlife Protection Study, Report No. 3, June 1964".

level. This is necessary to protect the opossum shrimp (Neomysis) and fish populations, particularly in the late summer and fall.

9. Help regulate the intermixing of Sacramento, Mokelumne, and San Joaquin River water during the peak of the salmon run to aid the homing ability of these fish.

The restoration and enhancement of the fishery resources dependent on the Delta are considered in more detail in three parts: (1) benefits from statewide water development and salinity control, (2) automatic benefits from the Peripheral Canal, and (3) benefits produced by proper operation of the Peripheral Canal.

## Benefits from Statewide Water Development and Salinity Control

The salinity gradient from fresh to sea water is usually about 50 miles long, extending from the western edge of the Delta to mid-San Francisco Bay. The gradient shortens when the Sacramento and San Joaquin Rivers are in flood stage, and lengthens as outflow decreases. The reduction of winter and spring floodflow through the Delta that will accompany statewide water development, together with the controlled releases from the Federal Central Valley Project and State Water Project reservoirs for salinity control to guarantee the November 19, 1965 Delta Water Quality Criteria, will cause the salinity gradient to become more stable and somewhat longer on the average with the upper end being controlled to approximately its present summer location for longer periods of time. This will enable:

1. Marine and freshwater fishes to establish more stable populations in the area where the gradient changes from brackish to fresh water;

2. Neomysis populations to become more stable in the western Delta. These animals are important food sources to fish and prefer water below 4,000 ppm chlorides; and

3. Benthic species that favor a more saline environment to establish more stable populations in the estuary between the western Delta and San Pablo Bay.

## Automatic Benefits from the Peripheral Canal

By changing the point of diversion from the southern Delta to the Sacramento River with the Peripheral Canal, the present impact of water transfer and pumping from the Delta will be eliminated, thus automatically restoring many of the natural hydrologic characteristics.

This improvement will: (1) eliminate the flow reversal which now occurs in over 50 miles of channel in the lower San Joaquin River and southern Delta; (2) allow more home-stream water released from upstream reservoirs on the San Joaquin River tributaries to pass through the Delta for migrating fish; (3) reduce net flow across the Delta with resultant moderate increases in TDS and nutrient concentrations. The foregoing improvements will benefit salmon, striped bass, resident warmwater fish, and the aquatic fish food organisms they depend on.

Salmon will benefit in three ways:

1. By removing one of the major barriers (reverse flow) to unrestricted passage of salmon bound for spawning areas in upstream tributaries. Annual rehabilitation goals of 55,000 spawners for the Tuolumne, 28,000 for the Merced, 19,000 for the Stanislaus, and 10,000 for the Mokelumne Rivers have been established;

2. By maintaining a substantial portion of San Joaquin River home-stream water in major migration channels to help guide salmon to their spawning grounds; and

3. By permitting juvenile salmon to migrate seaward through the Delta following natural migration routes without being drawn toward the pumps, salvaged, and transported by tank truck.

These improvements are needed to restore the once-abundant salmon runs of the San Joaquin River system. Large expenditures ($2 million on the Merced River alone), to obtain flows and rehabilitate spawning areas for salmon are planned and are being made on the assumption that the Peripheral Canal will be completed at an early date. Benefits from such expenditures cannot be achieved if the spawners cannot successfully pass through the Delta and reach their spawning grounds.

Striped Bass will benefit in two ways:

1. By reducing the loss of eggs and larvae at the export pumps. Diverting water at Hood on the Sacramento River will automatically reduce the proportion of eggs and larvae subject to the export pumps.

2. By eliminating mortality from handling and transporting salvaged fish. The system planned for the Peripheral Canal will return salvaged fish directly to the river and will be designed to minimize mortality from handling and from predation. A total of 41 million juvenile striped bass was hauled from the Tracy louver screen from June to August 1965 when pumping amounted to 700,000 acre-feet. Future pumping rates at this time of year will increase twofold.

Resident Warmwater Fish (such as catfish, largemouth bass, and crappie) will benefit from the reduced net flow in the main transfer channels thereby restoring quiet-water areas favored by these species. The additional angling opportunity created will help meet the expected increase of 65 percent in statewide angler use of warmwater fish by 1980 (4-1/2 million angler-days in 1963 to between 7-1/4 and 10 million angler-days in 1980).

Aquatic Fish Food will be benefited in two ways:

1. Improved conditions for benthic animals, such as *Corophium* and tendipedids, are expected to occur as a result of reduced scour and shifting sand in about 65 miles of channel bottoms, that would otherwise occur from the high net flows in the water transfer channels of the north Delta;

2. Improved conditions for zooplankton and opossum shrimp populations will result from longer residence time of the water and moderate increases in the dissolved minerals and nutrients in interior Delta channels; provided, adequate water quality is maintained through waste discharge controls.

## Benefits from Proper Operation of the Peripheral Canal

Additional benefits to fishlife will accrue if certain operating practices for the Peripheral Canal are observed. Final operational criteria for the Canal have not yet been set. Cooperative studies are underway by the Department of Fish and Game and the Department of Water Resources with the goal of establishing the best distribution and magnitude of releases from the Canal to protect and, where feasible, to enhance the various resources of the Delta in relation to the overall capability of the project. This section describes some of the factors involved, the general concept of operation, and opportunities to benefit fish and other aquatic life through proper operation.

Some Factors Affected by Canal Operation. Waters productive of fish are in a state of biological balance among the fish, other aquatic organisms, and physical and chemical factors of the environment. This natural balance, although not fragile, can be damaged by factors introduced by the users of water or by faulty practices of water management. Effects, either favorable or unfavorable, are reflected throughout the ecological chain. As the human population increases and our demands for available waters rise, the fishery manager and the water manager are faced with the problem of deciding how many times and for what purposes Delta waters may be used without losing the desired effects.

Waterflow characteristics, including quantity, quality, and velocity, control many aspects of fish distribution, the food chain relationships, and other biological relationships. As such they are not entirely separable from each other. Conversely, any one factors alone cannot guarantee a suitable environment for fish and other aquatic life.

For example, present evidence indicates that striped bass require water below 180 ppm TDS at temperatures between 60 and 65°F during the spawning period. Good production of zooplankton, the principal food for newly hatched bass larvae and fry, results in waters with low net velocities that are relatively rich in nutrients and with mineral concentrations between 200 and 700 ppm TDS. It is the intention of the Department of Fish and Game and the Department of Water Resources to establish operating criteria for the Peripheral Canal that will balance the need for striped bass spawning areas and fish-food-producing areas during the spawning period, and then gradually increase the critical food-producing areas after spawning is completed.

Work to date indicates that the Peripheral Canal and the criteria contained in the November 19, 1965 water entitlement agreement permit substantial operational flexibility to accomplish most and perhaps all environmental needs of fish and other aquatic life. This flexibility includes provision for positive downstream flow, limited net velocity, lower dissolved mineral concentrations at striped bass spawning time, and higher (over present conditions), but not too high, concentrations of dissolved minerals and nutrients in summer and fall to benefit fish food organisms.

It is important to maintain this operational flexibility. Each hydrologic year is different and the exact magnitude and timing to meet the desired environmental conditions are different each year. Studies of factors controlling dissolved oxygen, striped bass spawning, food sources for sustaining young bass, needed to establish operational criteria are incomplete. Prematurely setting additional water quality criteria could restrict a meaningful operating agreement between the Department of Fish and Game and the project operators, and possibly negate the fishery protection and enhancement potential of the project. Completion of the current studies followed by a meaningful period of trial operation are necessary to assure the desired results.

Concept of Canal Operation. In general, the concept for operation is to distribute the total amount of water needed for Delta agricultural use and controlled freshwater outflow for salinity control, plus any uncontrolled surplus flows not needed for export, in the best way to achieve a balance among all of the beneficial uses of Delta waters.

For example, during the winter months when surplus flows in the Sacramento River are normally high and requirements for zooplankton as fish food are small, leaching of salts from agricultural lands constitutes the primary use of water and would govern the operation of the Peripheral Canal. Even though water is not required for consumptive use, good quality (less than 100 ppm TDS) Sacramento River water would be conveyed through the Canal to upgrade the quality of San Joaquin River water. The blended water could be expected to range between 100 and 250 ppm TDS in most southern and eastern Delta channels under normal conditions.

During the early spring months striped bass migrate from the ocean and bay into fresh water to spawn. By conveying a portion of the Sacramento River water in the Canal that is required to meet irrigation and salinity control requirements, water could be blended to provide less than 350 ppm TDS in Old, Middle, and Mokelumne Rivers to encourage striped bass to move into these areas. Releases into the main San Joaquin River would be kept to a minimum to encourage good production of zooplankton.

During about a 30-day period in midspring when the water reaches the spawning temperature between 60 and 65°F, the Peripheral Canal would be operated for striped bass spawning in the Delta by providing sufficient areas of water with less than 180 ppm TDS. A balance would be maintained between spawning areas and fish food-producing areas.

In all but dry years, diversions for export would be kept at a minimum for a 30-day period during the peak of striped bass spawning in the Sacramento River. This would allow many of the free-floating eggs and larvae to drift past the Peripheral Canal intake into the central and western Delta and would enable them to hatch and grow away from the influence of the export facilities. If the historical spawning pattern prevails under future conditions, a larger proportion of striped bass would spawn below the Peripheral Canal intake in dry years; hence fewer eggs and larvae would be subjected to the pumps.

Beginning in summer as soon as spawning is completed, canal releases would be adjusted to increase residence time and concentration of dissolved minerals and nutrients in Delta channels to improve the supply of fish food for the newly hatched bass.

Beginning in mid-July, young striped bass usually shift from zooplankton to Neomysis for food. Because of this shift in food preference, a large portion of Sacramento River water needed to meet the high consumptive use and salinity outflow requirements in the eastern and southern Delta could be released from the Peripheral Canal without harm to the fishery. These large releases would assure positive downstream flows in most Delta channels to prevent the buildup of salts and pollutants, and would provide irrigators with the best possible quality of water throughout the remainder of the summer.

As the season moves into fall and the king salmon spawning migration begins, release of Sacramento River water from the Canal would be reduced, consistent with maintenance of adequate levels of dissolved oxygen, to assure a high proportion of "home-stream" water in the migration channels. This would aid salmon in returning to their spawning stream of origin. It would minimize the attraction of Sacramento River salmon into the southern Delta and dead-end sloughs where releases are made.

Operating Advantages. Operating criteria cannot be defined until studies are completed. But, a summary of the anticipated advantages to fishlife from proper operation of the Peripheral Canal, as now envisioned, is presented below:

1. Export pumping could be reduced during the striped bass spawning period to minimize losses of striped bass eggs and larvae at the Peripheral Canal intake. Although a much smaller (than present) percentage of eggs and larvae will be subjected to the influence of export pumping, a substantial number of striped bass will continue to spawn in the Sacramento River system above the canal intake.

2. Good quality water can be released from facilities along the Peripheral Canal to improve dead-end sloughs and into other Delta channels (such as the San Joaquin River near Stockton) where low dissolved oxygen levels occur that are detrimental to aquatic life.

3. Adjustment of flows and water quality through releases from the Canal could result in levels of total dissolved solids (TDS) low enough to permit striped bass to spawn in areas presently unsuitable for these fish in addition to maintaining most of the present key spawning areas. It is considered good management for spawning to take place over a wide area rather than in a limited area where an unexpected local detrimental condition could eliminate a substantial amount of reproduction.

4. Proper control of flows through releases from the Peripheral Canal could also result in water quality conditions more productive of fish food organisms at a time when they are needed most.

5. Flow releases, together with the elimination of flow reversal described earlier, will assure positive downstream flows in most all Delta channels to prevent the buildup of salts and pollutants and to aid fish migration.

## INDEPENDENT ANALYSIS BY FEDERAL AGENCIES

In its preliminary report of August 27, 1965, the U. S. Fish and Wildlife Service presented its own analysis of future Delta environment and its effect on fishery resources with and without the Peripheral Canal, proposed as a federal-state joint-use project.* Substantial fisheries enhancement attributable to the Peripheral Canal is indicated. The report states in part:

> "The Peripheral Canal Plan is the only proposal we are aware of that would provide water to state and federal pumps near Tracy and not have serious detrimental effects on the fish and wildlife of the Delta and the Sacramento-San Joaquin River systems. In fact, considerable fish enhancement possibilities are inherent in the Peripheral Canal concept through improvement of Delta habitat. In addition, a significant fishery value would result within the Canal itself.
>
> ***
>
> "Analyses of project effects upon the fish resources have been based on the provision of adequate fish screen and bypass facilities at the Hood intake and the installation of facilities at canal outlets that would keep anadromous fish from entering the Canal. If the releases from the outlets result in dead-ending of migrating anadromous fish in the Canal, it may be necessary to cut off water releases into dead-end sloughs during the migration period.
>
> ***
>
> "The proposed operational schedule of the Peripheral Canal would include releases into various dead-end sloughs and river systems. These releases would eliminate the Delta flow-reversal problems. In addition, removal of the present pollution block in the San Joaquin River below Stockton would contribute greatly toward saving the remnant San Joaquin River salmon runs. The overall long-term effect of the proposed releases will be expected to draw migratory fish species

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*Report of the U. S. Fish and Wildlife Service included as an appendix to the Bureau of Reclamation's Preliminary Feasibility Report on the Peripheral Canal Unit of the Federal Central Valley Project, dated April 1966.

> as well as resident species back into the San Joaquin system. This is a desirable aspect of the Peripheral Canal, provided that adequate spawning conditions and flows are available in the San Joaquin River and tributaries.

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> "All analyses of fish and wildlife effects were based on a minimum salinity repulsion outflow of 1,500 second-feet through the Delta into San Francisco Bay. If this minimum is not maintained, a reevaluation will be necessary. However, we believe the actual optimum outflow for fish and wildlife should be determined after the project is in operation through an extended program of monitoring water quality."

It should be noted that the U. S. Fish and Wildlife Service analysis of fishery enhancement is based on flow release schedules and minimum salinity control outflow that were contemplated prior to the November 19, 1965 Delta Water Quality Criteria. Operation under these later criteria will produce water quality at least equal to and probably better than that contemplated at the time the estimates were made.

Throughout its preliminary feasibility report of April 1966, the Bureau of Reclamation sets forth both fishery restoration and enhancement and water quality control as being among the purposes of the Peripheral Canal. The Bureau also indicates its intention that the Canal be operated for the benefit of fish. This is evidenced by such statements as:

> "...releases (from the Canal) would achieve water quality control not only for the fishery but for the agricultural lands of the Delta.";
>
> "...the releases (into various dead-end sloughs) would increase the dissolved oxygen content needed by the fish.";
>
> "Regulated releases from the Peripheral Canal would improve conditions in the Delta for increased production of American shad."; and
>
> "...water released from the Canal into dead-end sloughs, channels, and streams would provide a control on the quality of water and maintain a positive downstream flow for the removal of the pollution block and future rehabilitation of the upper San Joaquin River system."

## CURRENT AND FUTURE STUDY PROGRAMS

The statewide and national significance of the fish and aquatic resources of the Delta is apparent from the foregoing review. Both the California Department of Fish and Game and the U. S. Bureau of Sport Fisheries and Wildlife have enthusiastically endorsed the Peripheral Canal Plan. At the same time, however, they identified several areas requiring further investigation.

The Departments of Fish and Game and Water Resources are conducting additional biological and engineering studies to develop design and operating criteria for the project. Much of the additional work, however, because of its technical nature, its bearing on design, construction and operation, and the joint nature of the project, warrants participation by the appropriate agencies of both the State and Federal Governments.

For example, a decision must be made regarding the type of fish screening device at the Peripheral Canal intake. Each year millions of striped bass and shad fry will be drawn to the Canal. Tests over the past several years have clearly demonstrated that louver screening devices such as those at the federal and state pumping plants in the southern Delta will only be partially effective in saving the small fish reaching the Canal. A new screening concept has been developed and is being investigated from both the biological and engineering viewpoints. If this screening concept proves to be effective and feasible, it should permit some relaxation and greater flexibility in the pumping restrictions now planned during the peak occurrence of these small fish.

It will be necessary to continue monitoring certain biological aspects of the Delta environment during the interim period and following construction of the Canal, so that when the Peripheral Canal does go into operation, a base will have been established from which to evaluate the effectiveness of project facilities and water releases.

More precise information is being obtained concerning the factors controlling the time and location of striped bass spawning and the survival of young. This is necessary to realize the maximum potential for protecting and enhancing the population through Peripheral Canal operation.

The origin and mode of water delivery into the Delta during the upstream migration of salmon in the fall must be evaluated in conjunction with canal operation. The release of Sacramento River water with a disproportionately small quantity of San Joaquin River water would likely delay or prevent these fish from finding and ascending their "home-stream". Solutions under consideration are: (1) modification of canal facilities to pass fish; (2) adjustment of canal operation; and (3) provision for exchange of Sacramento River water with San Joaquin water.

Studies are now under way to define the mechanisms by which hydraulic conditions, water chemistry, algae growth, and other factors control dissolved oxygen. Study results will be used to plan an effective program to prevent dissolved oxygen problems and their adverse effects on fish and other aquatic life. Part of the management of the Delta environment will involve scheduling the timing and quantities of releases from the Peripheral Canal to aid in preventing adverse oxygen conditions, and part will involve control of waste discharges.

## A-P-P-E-N-D-I-X

## SUMMARY OF FISHERY BASIS FOR SELECTION OF THE PERIPHERAL CANAL PLAN FOR THE DELTA

In January 1965, the federal-state Interagency Delta Committee recommended the Peripheral Canal concept as the best alternative for adaptation to the full range of water-associated needs in the Delta, while meeting the water transfer requirements of the state and federal water projects. This recommendation was made after more than three years of careful study of Delta problems and the numerous alternative plans which were grouped into four basic concepts:

1. Hydraulic Barriers - The transfer of water for export through existing Delta channels, accompanied by large releases of water from upstream storage reservoirs for salinity control;

2. Physical Barriers - The transfer of water for export through existing Delta channels, with salinity control accomplished by a single barrier (low-level dam) in the bay system west of the Delta;

3. Waterway Control Plans - The transfer of water for export through hydraulically controlled and modified Delta channels with the present level of salinity control accomplished by a continuation of moderate releases of water from upstream storage reservoirs. Water supply in the western Delta would be provided through overland facilities; and

4. Peripheral Canal Plans - The transfer of water for export through a new, hydraulically isolated channel around the Delta, with the present level of salinity control accomplished by a continuation of moderate releases from upstream storage reservoirs. Irrigation water of adequate quality would be provided for the Delta by a combination of controlled freshwater releases from the Canal and overland water facilities in the western Delta.

The effect that each alternative plan would have on factors related to fish and other aquatic life is reported in the Third Annual Report of the Delta Fish and Wildlife Protection Study, dated June 1964. A summary of the effects of the four water plans on six important environmental factors, in relation to present conditions, is shown in Table 1 of that report. This table is included here as Table A-1 for convenient reference. The conclusions reached were supported and the Peripheral Canal Plan was endorsed by the U. S. Fish and Wildlife Service.

In providing an overall rating for each plan, the Department of Fish and Game concluded that:

> 1. The Hydraulic Barrier Plan would only increase existing environmental deficiencies and would eliminate the San Joaquin and Mokelumne River anadromous fish runs and would likely reduce the striped bass populations that now spawn in the Sacramento River system.
>
> 2. The Physical Barrier Plan is the least desirable plan and would be particularly detrimental to the two most important fish species -- both of which are migratory -- the salmon and the striped bass. This plan would virtually eliminate the long, gradual salinity gradient in all Delta channels and would cause more frequent and more extensive flow reversals in the San Joaquin River and south Delta channels. It would probably result in almost total loss of the striped bass due to the egg settlement and suffocation and complete loss of the San Joaquin River salmon run without chance of rejuvenation.
>
> 3. The Delta Waterway Control Plan would, under proper operation, do no harm to the Sacramento River anadromous fish runs and could solve the flow-reversal problem facing today's San Joaquin and Mokelumne River runs. It would probably further restrict the movement of these fishes into the south Delta and would damage catfish populations there through a reduction of their food supply.
>
> 4. The Peripheral Canal Plan is the most desirable plan and, in fact, the only plan that can fully protect the fish and aquatic resource of the Delta and also provide opportunities for enhancement. Properly operated, this plan can maintain a long, gradual salinity gradient, provide a positive net flow toward the sea in most all Delta channels, minimize the loss of striped bass eggs and larvae, improve environmental conditions necessary for high population of fish food organisms, and maintain important tidal action.

> 5. In summary, based on intensive biological studies, it was concluded that the Peripheral Canal Plan is the most desirable plan for Delta Water Facilities, and it is the only plan that will fully protect and offer enhancement opportunities for fish and wildlife. "We recommend its construction at the earliest possible date." (emphasis added).

In November 1964, prior to completion of the Committee's final report, the Peripheral Canal received widespread support by federal, state, and local interests at a public hearing before the California Water Commission. Local interests commenting to the Commission included agricultural groups, water districts, county and city levels of government, sportsmen's groups, and the commercial fishing industry. In his comments to the Committee, Chairman Ralph Brody said:

> "An interesting aspect of the hearing was that for the first time in our memory, large groups of fish and wildlife and recreation interests supported almost without qualification a proposed water project. In fact, the entire San Francisco Bay fishing fleet declared a holiday so that the skippers and their families could be present for the hearing."

Subsequently, the Department of Water Resources and the U. S. Bureau of Reclamation selected the Peripheral Canal Plan for development as a joint state-federal Delta water facility as the Delta link in the California State Water Project and the Federal Central Valley Project.

The Department of Water Resources has authority to construct the Canal alone or by joint venture under the 1959 California Water Resources Development Bond Act. The Bureau of Reclamation is completing a feasibility report on the Peripheral Canal as an additional unit of the Central Valley Project, but needs authorization from Congress to proceed as a joint project with the State.

Since selection and adoption of the Peripheral Canal, work of the Delta Fish and Wildlife Protection Study has been directed toward developing design and operating criteria for the Canal that will assure protection and, where feasible, enhancement of the Delta environment for fish and other aquatic life.

## TABLE A-1

### SUMMARY OF THE EFFECTS OF THE FOUR WATER PLANS ON THE SIX CHARACTERISTICS OF THE DELTA ENVIRONMENT CRITICAL FOR THE PROTECTION OF FISHERY RESOURCES

| | Present | Hydraulic Barrier Plan | Chipps Island Barrier Plan | Delta Waterway Control Plan | Peripheral Canal Plan |
|---|---|---|---|---|---|
| 1) A Long Salinity Gradient | 50 miles | 50 miles | Eliminated | 50 miles | 50 miles |
| 2) A Positive Net Flow Toward the Sea | Always positive in Sacto. River & N. Delta. Reverse flow in S. Delta & parts of San Joaquin River during dry season. Duration of reverse flow will increase in future. | Always positive in Sacto. River & N. Delta. Reverse flow in S. Delta & all of San Joaquin River often year-round. | Always positive in Sacto. River & N. Delta. Reverse flow year-round in S. Delta & all of the San Joaquin River. | Always positive in Sacto. River & in San Joaquin River. Reverse flow year-round in S. Delta. | Always positive in both rivers & all Delta channels. No reverse flows. |
| 3) Means to Prevent Striped Bass Egg Losses into Large Diversions | Offers no solution to present loss estimated to be 15-30%. | Offers no solution to egg loss estimated to be at 50% or more. | Egg loss almost 100% due to settling & suffocation. No solution. | Egg loss can be reduced to 6% by operation. | Egg loss can be reduced to 6% by operation. |
| 4) Conditions for Zooplankton Populations | Poor in N. Sacto. River & N. Delta channels. | Poor in N. Sacto. River & N. Delta channels. Some reduction in S. Delta channels. | Unknown. | Poor in N. Sacto. River in N. Delta channels & S. Delta channels. | Significant increase in N. Sacto. River in N. Delta channels where zooplankton is now scarce. |
| 5) Conditions for Benthic Production | Excellent in most of Delta channels. | Poor in N. Delta channels. | Unknown. | Poor in N. Delta channels & in Old-Middle River channels of S. Delta. | Excellent in almost all Delta channels. |
| 6) Tidal Currents | Adequate in most Delta channels. | Adequate in most Delta channels. | Eliminated in all Delta channels. | Adequate in most Delta channels with single-purpose plans. | Adequate in most Delta channels. |

Source: Table 1, page 28a of Delta Fish and Wildlife Protection Study, Report No. 3, June 1964.

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